# VENTILATING

A MONTHLY MAGAZINE FOR ENGINEERS AND CONTRACTORS CONCERNED WITH COMMERCIAL, INDUSTRIAL AND INSTITUTIONAL AIR CONDITIONING, REFRIGERATION, AIR SANITATION, PIPING, HEATING AND VENTILATION

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## THIS MONTH'S COVER

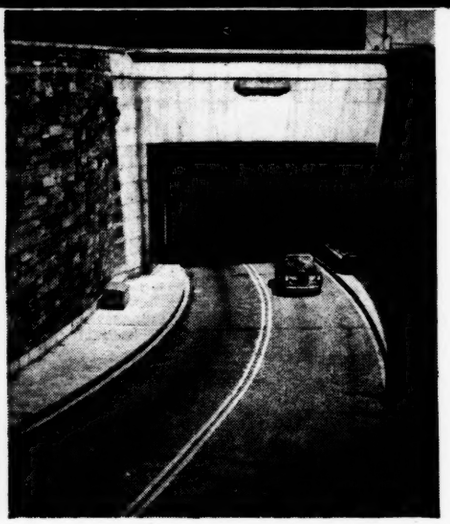
During the war, five miles of London's underground railway tube were converted to an air conditioned factory. Photo shows machinery in line, with tracks for electric conveyor trucks at right and power conduit overhead. Air ducts are under floor as described beginning page 74.

# LONGEST VEHICULAR TUNNEL IN

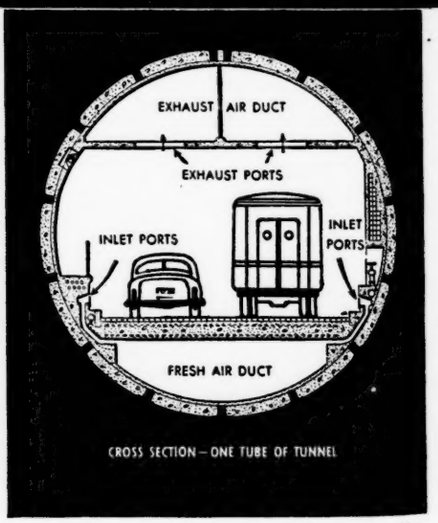
**1.** HERE'S THE SITE of the Brooklyn-Battery Tunnel—from Manhattan, to Governors Island, to Brooklyn. More than a mile and a half long, it will require equipment capable of moving 24,000 tons of air per hour. For a project of this magnitude, it's only natural that Sturtevant should supply the ventilating fans. The name "Sturtevant" has been associated with tunnel ventilation from the very beginning. For example:

## 11 OF THE 14 MAJOR VEHICULAR TUNNELS IN THE ARE VENTILATED WITH STURTEVANT

**2.** THE HOLLAND TUNNEL—first project of its kind, and at that time one of the great engineering wonders of the world—is completely ventilated by Sturtevant. Completed in 1927, this 8,368-foot tunnel was equipped with a total of 92 Silentvane Fans. Since then, much experience has been gained in the efficient ventilation of under-water tunnels of this type.



**3.** IN THE QUEENS-MIDTOWN TUNNEL, completed in 1940, it was found that ample ventilation could be supplied by a total of 46 fans—23 blowers and 23 exhausters. This 6,343-foot tunnel under the East River, is also completely Sturtevant-ventilated. The Holland, Lincoln, Queens-Midtown and Brooklyn-Battery Tunnels all utilize the "distributive" method of ventilation. Here's how it works:




**4.** The spaces above and below the tunnel roadway serve as air ducts. Fresh air, supplied by blower fans, is discharged from the duct below the roadway, through openings distributed along its entire length. Air and fumes rise to the ceiling, are drawn out by exhaust fans, through the return duct above the road. The system must be *completely dependable,* year in and year out. That's why—

HEATING • VENTILATING • AIR CONDITIONING •

DRYING • DUST AND FUME CONTROL • CONVEYIN

# Washington News

LORING F. OVERMAN

**Mr. Wallace and the Engineers.**
**Wage Formula.**
**Decontrol.**
**Multiple Housing.**
**Priorities and Set-Aside.**

CONSIDERING the fact that September was supposed to be a quiet month in Washington, with Congress at home and no particular excitement anticipated, few recent four-week periods have turned up more things of interest to the country as a whole, not excepting the heating, ventilating and air-conditioning industries.

Most dramatic of the developments was Henry Wallace's vocal expedition into the field of foreign policy, and his subsequent forced resignation as Secretary of Commerce.

Then came the Administration's surrender to strike pressure from seamen, and the implication of a further break in the Wage Stabilization Board's wage policy.

Another development involved OPA's interpretations of the new Price Control Extension Act, including issuance of procedural regulations prescribing methods of applying for price relief or decontrol.

A fourth was the Housing Expediter's additional orders intended to channel more and more building materials into the veterans' housing program.

### Wallace Aftermath

Whether or not, as Wallace outlined in his Madison Square Garden speech, the Nation's present foreign policy invites war, the Administration appears committed to the policy and is making its plans accordingly. These plans concede the possibility that war, while improbable, could conceivably result from a misstep somewhere along the line. To prepare for such an eventuality, Federal budgets for some years may reasonably be expected to include items of $10 billion or so annually for development and support of the military.

Having experienced the effects of military purchases during the last five years, the heating, ventilating and air-conditioning industries will be in a position to assay the possibilities of a program scheduled to continue for some time at a 10-billion-dollar-per-year pace. While such an annual expenditure would be only a fraction of that disbursed during the war, it would represent a sum considerably higher than all costs of government, including the military, prior to 1941. A generous share of the industry's drawing boards, research equipment and production facilities must continue to be reserved for the military projects, it would appear.

### New Wage Formula?

The Administration's hasty retreat from the wage formula it has instructed its Wage Stabilization Board to enforce in the face of the maritime strike, brings up another question which cannot help but affect various segments of the heating, ventilating and air-conditioning industries. Expected soon is an announcement of a new wage policy permitting increases of approximately 10%, with an escalator clause permitting further increases early next year to reflect any upward change in living costs. June, 1946, has been mentioned as the probable new base period upon which escalator provisions would be figured.

Theory is that with living costs mounting, a new wave of strikes next Spring is inevitable unless some upward adjustment is authorized. That the new policy may be announced as a pre-election gesture toward labor is not to be discounted. Both the Administration and top union men would welcome a cessation of labor strife, particularly at election time. Too, they figure that a new formula, even if announced a few months ahead of its anticipated release date, would probably last until next June, when OPA will end and both wage and price controls will cease.

In any event, in any section of industry where labor costs have a bearing upon finishing the job, it will be necessary to think in terms of increased labor costs —and soon.

### Decontrol in Action

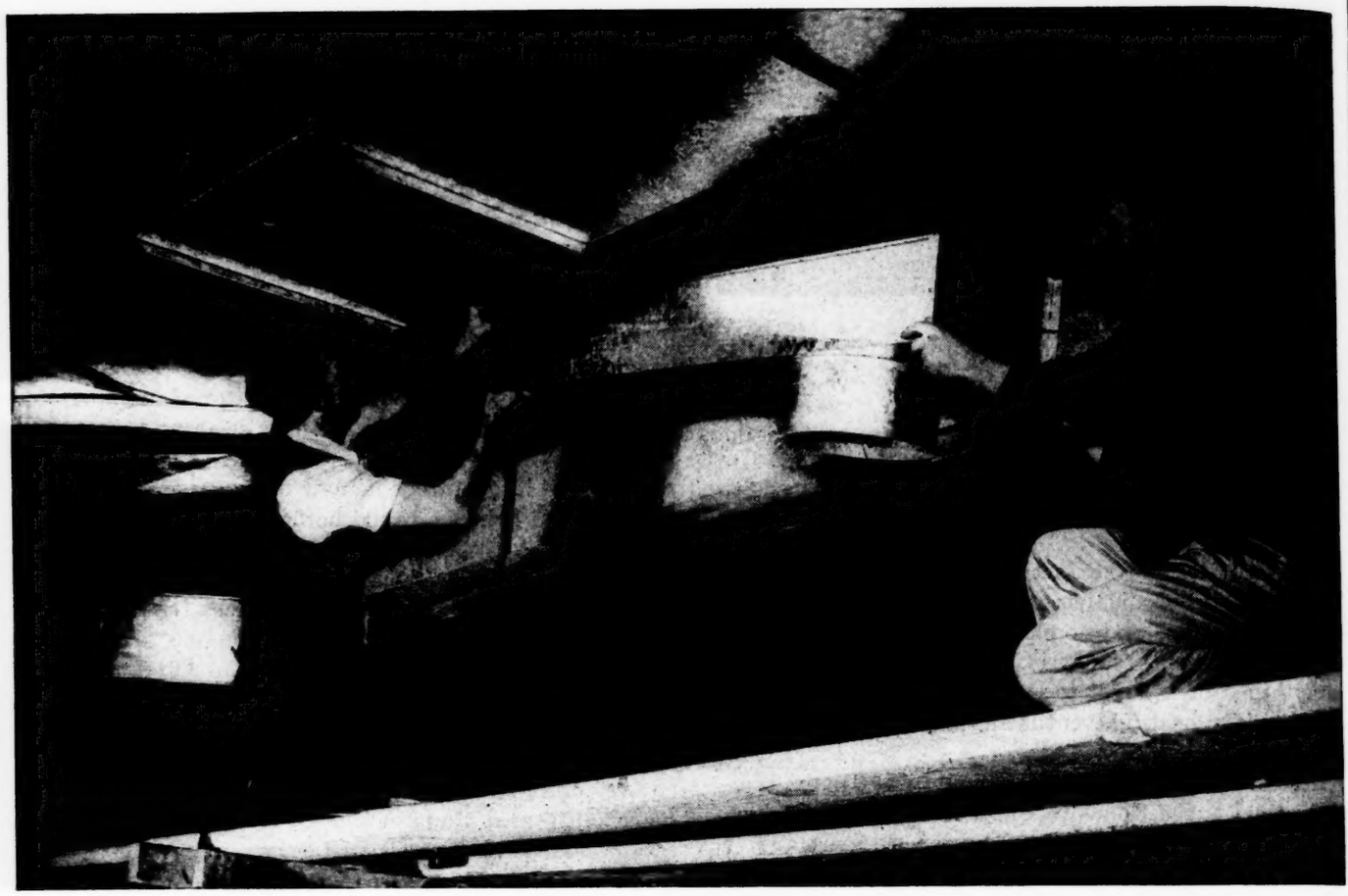
Businessmen who have bumped up against OPA's new regulations prescribing procedures for seeking decontrol or price adjustments are somewhat puzzled. It was generally understood that Congress wanted prices decontrolled speedily, and that the Barkley amendment prohibited the imposition or maintenance of controls failing to permit "a reasonable profit" after making adjustments for increased costs of labor and materials. Shortly after passage of the Price Control Extension Act, Price Administrator Paul A Porter assured business, in a wordy press release, that OPA would "abide by the letter and spirit of the law, and not circumscribe the regulations with red tape."

This all sounded interesting, if true, but new regulations pose an almost impossible statistics-collecting job upon industry advisory committees seeking decontrol. Similarly, up to September 20, not a single industry advisory committee had attempted to apply for relief under the Barkley amendment, so involved are the requirements.

### Housing – or Nothing!

If the government can't induce, force, or cajole the building industry to complete the veterans' housing program projected for 1946 and 1947, it won't be because Housing Expediter Wilson Wyatt isn't using every trick in the book to get things done.

Whether or not it is wise to solve a specific portion



# Here's a market that's 97% untapped

An estimated 97 per cent of the nation's potential air-conditioning market remains to be developed and sold.

On this basis additional air-conditioning equipment totalling around 45 million hp capacity will have to be installed before the demand is fully satisfied.

That means a lot of work for manufacturers of air-conditioning equipment . . . and the installation of many miles of ductwork for central-station air-conditioning systems. To be satisfactory these ducts must combat the corrosive effects of circulating air that may be alternately humidified or dehumidified, heated or cooled, depending on weather conditions.

Beth-Cu-Loy Galvanized Sheets have the corrosion-resistance needed for this work. Their 0.20 to 0.30 per cent copper content gives these sheets from two to three times the corrosion-resistance of ordinary sheet steel or iron. And the uniform zinc coating of Beth-Cu-Loy Sheets forms a tight, protective armor that offers rust no starting point.

Another Beth-Cu-Loy advantage is high ductility. Beth-Cu-Loy takes readily to the brake, to hammering, to cutting and to soldering. You will get clean, workmanlike ducts every time with Beth-Cu-Loy. Use it on your next central-station air-conditioning job.

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## Beth-Cu-Loy Galvanized Sheets

BETHLEHEM STEEL

of the housing problem at the expense of commercial and industrial construction remains to be seen. But facts are facts. If it isn't "housing" (or a hospital, school, or other project not only essential but actually non-deferable), it stands a small chance of being completed soon. Thus, for the balance of '46 and all of '47, the heating, ventilating and air-conditioning industries may find it easier to ride with the tide.

Encouraging is the fact that, with the school housing problem nearing solution, major attention is being focussed upon rental housing, including large apartment developments. Gone from the favored spotlight is the individual small house. Recent surveys have indicated that mighty few veterans are either disposed or financially able to purchase individual homes at today's prices.

### Rental Movement Nation-wide

Latest move of NHA to encourage large-scale projects is the issuance on September 25 of a new booklet, "Rental Housing for Veterans." A full-scale study of basic procedure, the publication embraces such phases as planning, investment prospects, use of FHA credit facilities, architectural considerations, rent controls and ceilings, tax factors, mortgage terms, and other matters of interest to investors, financial institutions, builders, the building materials industry, and real estate concerns. The new booklet, available through Washington, D. C. and field offices of NHA and FHA, includes illustrations of a number of rental projects in various parts of the country, suggested floor plans, and reproductions of FHA forms used to initiate projects.

Indicative of the change in NHA thinking from single-unit to multi-unit housing is Mr. Wyatt's foreword, in which he describes rental housing as the virtual keystone of the veterans' housing problem "because hundreds of thousands of veterans are not in a position to buy or build homes."

Together with its new brochure on rental housing, the National Housing Agency is giving wide publicity to a bank of America plan of financing large-scale operations of home builders. The plan stems from the fact that one of the serious obstacles to launching of large-scale operations is the problem of financing the operative builder's cost of land acquisition and site development.

As explained by Mr. Wyatt, the great advantage of the new plan is that the operative builder, at the time the project is started, can arrange financing for a substantial part of the purchase price of the raw acreage and for site improvement costs, and still have some funds for initial construction. In contrast, the first advance under the traditional construction loan procedure is ordinarily not made until some work has been performed on the erection of the structure, and the amount of such advance is usually limited to the cost of the structural improvements, exclusive of land acquisition and site improvement costs.

Thus, with the emphasis shifted to multiple-unit dwellings, and with both financing and materials priorities given the green light, it would appear that the services and products of the readers of this column may be called into the veterans' housing picture to an extent not anticipated when the program was launched.

### Some Shortages Ending

The Construction Division, Department of Commerce, reported on September 24 that brick, tile, concrete block, clay sewer pipe, warm air furnaces and cast iron and convector radiation—all items that have been short—are now being produced in such quantities that the supply is approaching a balance with demand. Supplies of lumber, cast iron soil pipe and plumbing fixtures will remain short during 1947, the Division predicts.

These estimates cover quantities of materials actually required to be put in place, the Department of Commerce explained, and do not include necessary inventory buildup.

### Cut-Backs Continue

Reflecting the ear-marking and set-asides required by the Housing Expediter, current weekly denials of applications for non-housing construction exceed approvals, CPA reported on September 25. Total non-housing construction approved and denied by CPA's 71 district and 10 regional construction offices between March 26 and September 12 amounted to: approved, 49,777 applications worth $1,877,322,000; denied, 33,309 worth $1,325,015,000.

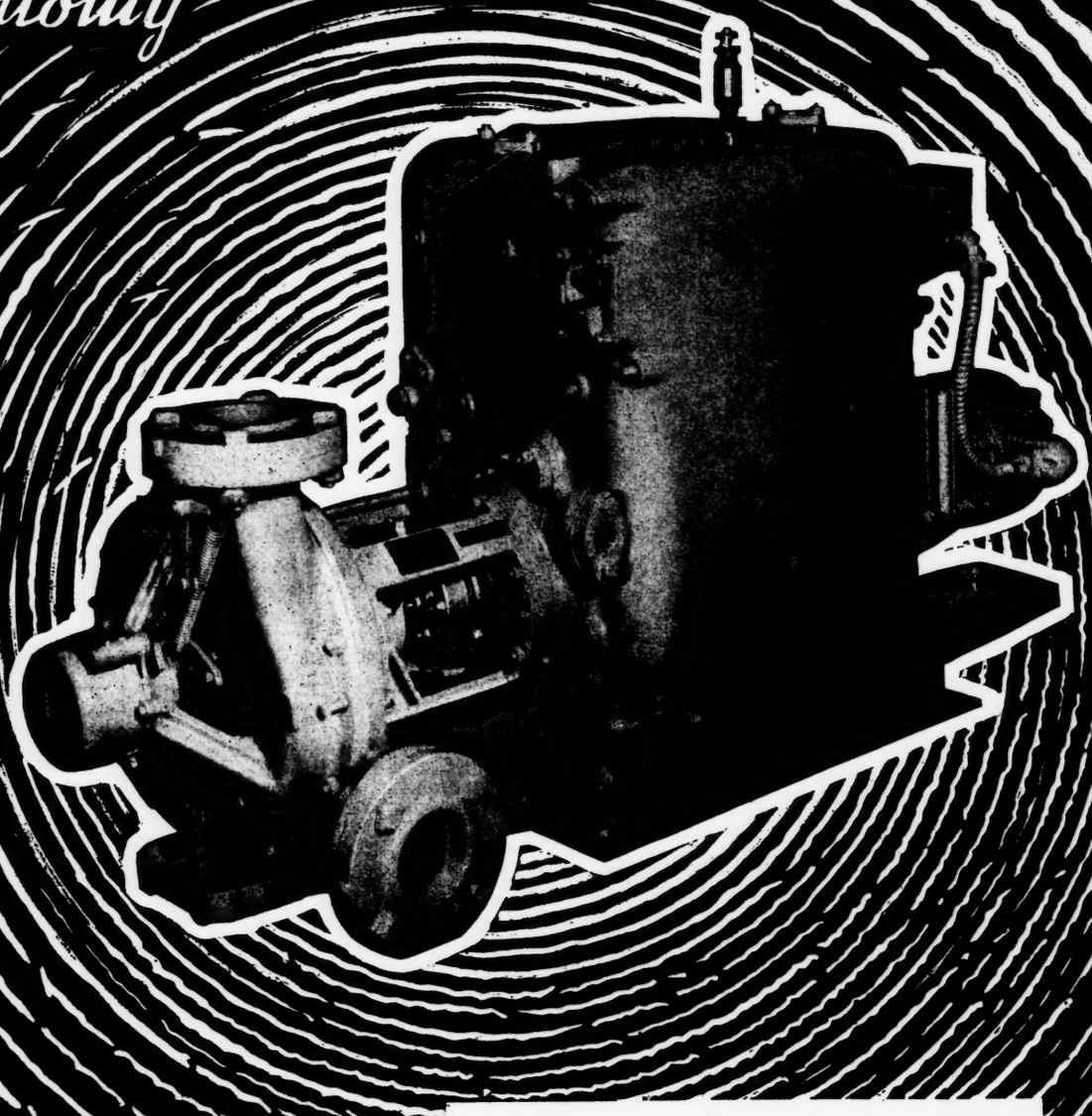
The one notable downward movement during August was an 8-million-dollar decrease in expenditures for privately financed new commercial buildings, revealing the first clear effects on expenditures of restrictions on non-housing construction. Commercial building was affected first because less construction time is required to complete the backlog of this type of work started prior to March 26. Not only can stores, restaurants, service stations, etc., be built in a shorter period than most factories and warehouses, but the dollar volume of essential construction authorized was less in commercial than in industrial building.

### Materials "Ear-Marked"

Just how serious Mr. Wyatt is about seeing that his veterans' program gets what it needs, may be concluded by examining September set-aside provisions affecting lumber and 59 groups of building items. Eleven of the 59 building materials items ear-marked must actually be held in physical inventory, subject to release only by Regional Housing Expediters. Included among the 11 is radiation (convector and cast iron), 75% of which—based on square feet of heating surface or producers billing price for convectors without enclosures—must be physically held for HH and other ratings. On 44 other critical materials, dealers are required to honor HH ratings up to 75% of their monthly deliveries. Included are many items of direct concern to H & V readers

Other items on the list, while of less direct interest to readers of this column, will be conspicuous by their absence in projects other than housing. Their absence, in turn, precludes the completion of non-housing projects which would otherwise embody heating and air-conditioning equipment.

*Centralized Heating Economy*



## A RETURN LINE VACUUM PUMP THAT CUTS HEATING COST.

This unusual pump needs no electric current, cutting out greatest item of pump operating expense.

More important, this pump insures absolutely uniform circulation in system. That means continuous steam economy.

Simple, compact, one moving element, no wearing parts, no internal lubrication. Bulletin No. 203 gives the facts. Your copy is waiting.

THE NASH ENGINEERING COMPANY
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HEATING AND VENTILATING

# Does Night Shutoff of Heating Pay?

ARTHUR S. GRISWOLD

Staff Engineer, Central Heating Dept.,
The Detroit Edison Co., Detroit, Mich.

**The author reports tests on Detroit's Kales Building, right, which show that steam consumption in this office building was 20% higher when steam remained on than when shut off at night. Mr. Griswold concludes that in moderate weather, night shutdown can effect savings of 25% and over.**

THE night shutoff of building heating systems is a subject which is frequently discussed. Some authorities claim that the amount of heat required to restore temperatures to the desired level after the night shutoff is greater than the amount of heat saved during the shutoff period, while others hold that an important saving in heat can be accomplished.

This subject is of particular interest to district heating companies engaged in the sale of steam where the cost of heating service to the customer must be kept at a minimum in order to compete successfully with other methods of heating. For these companies two important points are involved: (1) the steam consumption of the customer, and (2) the capacity of the steam generating plant and distribution system which must be available to serve customers during the coldest winter days.

In an effort to determine some of the effects of the night shutoff operation, tests were made during the heating season of 1945-46 on the Kales Building at 76 West Adams, Detroit, Mich. Steam for heating this building is purchased from The Detroit Edison Company at a nominal pressure of 35 lb per sq in. In these tests, the heating system was operated at different periods with its normal 10-hour night shutoff program, and with the steam on continuously, and measurements made of steam consumption peak load and other relevant conditions.

Data obtained indicate that with 24-hour heating, the steam consumption for days having a mean tem-

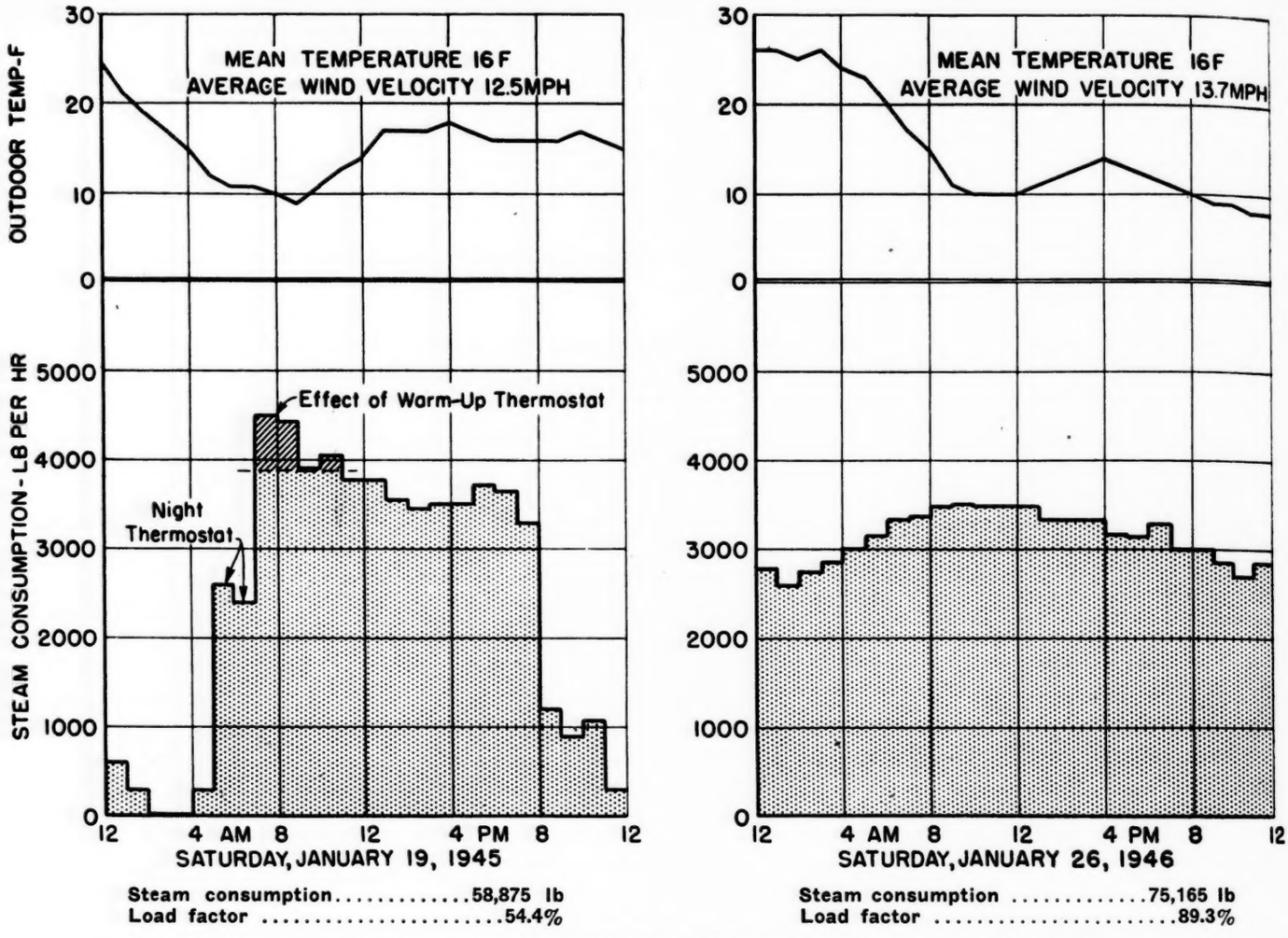

MEAN TEMPERATURE 16 F
AVERAGE WIND VELOCITY 12.5MPH
OUTDOOR TEMP-F
STEAM CONSUMPTION - LB PER HR
Effect of Warm-Up Thermostat
Night Thermostat
12 4 AM 8 12 4 PM 8 12
SATURDAY, JANUARY 19, 1945
Steam consumption.....58,875 lb
Load factor .....54.4%
MEAN TEMPERATURE 16 F
AVERAGE WIND VELOCITY 13.7MPH
12 4 AM 8 12 4 PM 8 12
SATURDAY, JANUARY 26, 1946
Steam consumption .....75,165 lb
Load factor .....89.3%

**Fig. 1. Steam consumption load curves when heating with normal night shut off and with 24-hour operation. Radiator heating surface in building, 21,405 sq ft. E.D.R. heated space 1,338,320 cu ft.**

perature above 16F was approximately 20% higher than when the normal ten-hour night shutdown schedule was followed. Satisfactory data were not obtained on colder days but it is believed that these same consumption relations would persist. Under the test conditions with outdoor mean temperatures 16F or higher, the peak load was appreciably lower on the days during which heating was on a 24-hour basis. The trend of the data, however, indicate that when outdoor temperatures fall to zero or below, the demand or peak load with continuous heating probably would nearly equal the demand with normal heating.

## Heating System Tested

The Kales Building is a 19-story downtown office building on a lot 80 x 100 feet. Its volume is 1,338,320 cu ft and the heating system has 21,405 sq ft EDR. A considerable number of the occupants are engaged in practicing medicine.

The building's main heating system is downfed and is divided into three zones. Each zone has an automatic on-off heating control with an outdoor element designed to supply steam to the radiators in accordance with the outdoors temperature. Time clocks provide automatic shutoff from 8 p.m. to 6:45 a.m. and reduce the hours of heating on Sundays and holidays to from 10 a.m. to 4 p.m. An additional clock provides an appropriate shutdown of the vacuum pumps. Separate thermostats are installed to maintain temperatures of not less than 60F at night and to maintain continuous heating until the building is up to 70F during the morning warm up. All radiators are equipped with adjustable type orifices. The building lobby and one store have independent heating systems.

The operators of this building have developed a carefully worked out heating and control system, and rigorously follow economical heating practices. Room temperatures are maintained at about 75F from 8:30 a.m. to 8:00 p.m. The ability of these operators is somewhat above the average.

## Test Results

Continuous heating was used during nine days of December, 1945, and January, 1946, while the mean outdoor temperatures were from 37 to 16F. Inasmuch as there were only a few really cold days during this heating season, and nearly all of these were on Sunday, data on colder days could not be obtained.

During these tests, the manual switches of the heating control were set to provide 24-hour heating control operation. This made the time clocks inoperative. No other changes or adjustments were made. Steam consumption data were obtained from the condensate meter register and demand attachment. Steam for

domestic water heating was registered by a separate meter and is not included in the data under consideration.

*Steam Consumption.* A comparison of steam consumption on two similar days is shown in Fig. 1. The total steam used for normal operation with night shutoff was 58,875 pounds and the consumption for continuous heating was 75,165 pounds. The increase in consumption with continuous heating therefore was 16,290 pounds or 25% above the normal use. Data presented in Table 1 show that for 9 days of approximately equal temperature, the consumption was 20% higher with continuous heating than with the normal (night shutoff) heating program.

*Peak Load.* The load curves in Fig. 1 show that the peak hourly load with continuous heating was well below that with the night shutoff. This, of course, would be expected in the moderately warm weather. After the night shutoff, steam must remain on continuously for a considerable period to restore normal room temperatures.

In an effort to estimate the comparative peak loads at lower temperatures, the maximum hourly steam consumption for each day during December, 1945, January, 1946, and February, 1946, was plotted against the 7:00 a.m. outside temperature as shown in Fig. 2. The points for normal heating appear to be somewhat erratic and it is interesting to note that two of the highest consumptions were found when the outside temperature at 7:00 a.m. was near 30F. With the warm-up thermostats of the heating control system, the steam stays on continuously for a varying period after heating is resumed in the morning. It is probable that on these two days, the heating was nearly continuous for the hours in question.

It is also interesting to note that with normal operation, the maximum hourly consumption with 7:00 a.m. temperatures near zero was slightly under 5,000 pounds per hour. This appears to be approximately the maximum possible condensation rate for the building's heating system.

The maximum hourly consumption for the nine days during which heating was continuous are clearly identified on Fig. 2. It will be noted that these points are much more consistent than those for the normal heating program. A straight line drawn through these points indicates that when the temperature drops to zero the maximum hourly steam consumption with continuous heating will be approximately the same as with the normal operation including the night shutoff.

*Daily Load Factor.* Daily load factors for 9 days of normal heating and 9 days of 24-hour heating are given in Table 1. Because of the high consumption which occurs during the warming up period the load factor for the normal heating is erratic and low, averaging only 47.1%. With continuous heating the load factor is high, averaging 83.8%. This is as would be expected.

**Table 1 — Consumption and Load Factor Data from 24 Hour Heating Tests on Kales Building**

| Date | Degree Days (65F Base) | Steam Consumption—Pounds | | Load Factor, % |
|---|---|---|---|---|
| | | Max.—1 Hour | Total—24 Hours | |
| **Normal Heating Program** | | | | |
| 2-6-46 | 29 | 3570 | 49,200 | 57.3 |
| 7 | 40 | 4800 | 58,500 | 50.8 |
| 8 | 32 | 4500 | 32,100 | 29.8 |
| 9 | 33 | 3600 | 43,800 | 50.7 |
| 10* | 46 | 4650 | 37,300 | 33.4 |
| 11 | 39 | 3900 | 50,000 | 53.3 |
| 12 | 28 | 4200 | 38,200 | 37.8 |
| 2-15-46 | 55 | 4500 | 57,100 | 52.9 |
| 2-27-46 | 44 | 3870 | 53,700 | 57.9 |
| Total Degree Days, 346; Pounds Steam per Degree Day, 1212**; Average Load Factor, 47.1%. | | | | |
| **Continuous 24 Hour Heating** | | | | |
| 12-5-45 | 33 | 2850 | 51,980 | 75.8 |
| 6 | 33 | 2400 | 48,500 | 83.4 |
| 7 | 27 | 2400 | 44,000 | 78.3 |
| 8 | 25 | 2400 | 40,100 | 79.5 |
| 9* | 33 | 1650 | 34,100 | 85.1 |
| 10 | 39 | 2970 | 66,700 | 93.4 |
| 11 | 47 | 3180 | 62,700 | 82.0 |
| 1-25-46 | 49 | 3300 | 66,450 | 83.8 |
| 1-26-46 | 52 | 3500 | 75,165 | 89.5 |
| Total Degree Days, 338; Pounds Steam per Degree Day, 1447; Average Load Factor, 83.8%. | | | | |

*Sunday.

**For period September 10, 1945 to March 29, 1946, consumption was 1200 lb per degree day.

## Conclusions

In summarizing the results of these tests, there is no doubt that an important saving in heat can be accomplished if the night shutoff practice is followed. The extent of the saving will depend upon the hours of occupancy, the minimum practical night temperature, and other considerations. In most buildings night shutoff can be practiced without interfering with the comfort of the building occupants. In moderate weather this saving may exceed 25%.

Where night shutoff is practiced the heat requirement, to restore normal daytime room temperatures will be higher than is the peak consumption for continuous heating except during the coldest winter days. During these cold days heating frequently must be on a 24-hour basis because of the limited capacity of the building heating system. Thus the night shutoff practice appears to have no appreciable effect on the capacity which must be available in a commercial steam distribution system. Most of the questions concerning night shutoff seem to relate to the ability to restore room temperatures quickly in the morning. Where the building purchases its steam, a large supply is available immediately after heat is turned on in the morning. The radiators fill rapidly and normal conditions are reached, usually in much less than one hour.

Where the buildings are heated by small individually fired units a considerable period of time elapses after heat is turned on before the heating system begins to function at its maximum capacity. In addition, the fuel burning capacity may be so limited that in the morning after the shutoff the temperature rise is unreasonably slow and under the forced conditions, the furnace efficiency will be lower than with continuous heating. These factors may create the impression that there is no saving with the night shutoff. The fact that the heat loss from a building depends upon the difference in temperature between the heated space and out-of-doors is universally accepted, and there should be little doubt concerning the value of the practice.

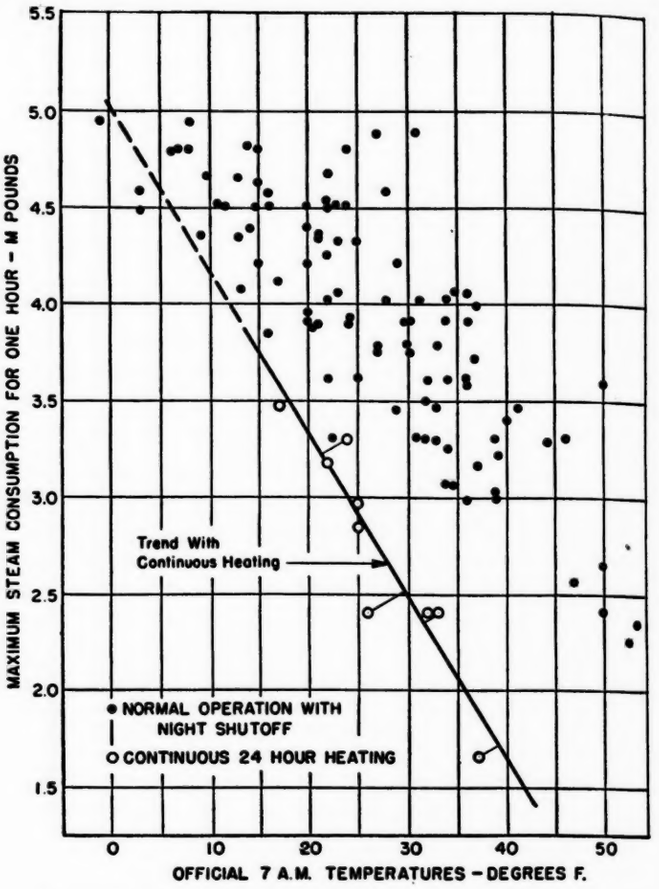



**Fig. 2. Maximum steam consumption for one hour with normal heating program and with continuous 24-hour heating.**

## Some Advantages of Unit Heaters

The speedy response of unit heaters (without presetting of controls) to heat demands caused by changes in outside temperature is particularly important to the maintenance of comfortable conditions in boundary areas of the industrial plant layout, and where there is frequent traffic between outside and inside plant areas. Ease of control is attained by simple thermostatic or manual controls.

The addition of simple accessories enables the unit heater to meet ventilating requirements invariably linked with the heating problem of industry. Fans can be designed to provide the necessary changes of air per hour . . . and can be operated independently in warm months to provide well distributed cooling air circulation throughout the entire plant. The economy offered by such an arrangement is obvious.

Fewer valves, traps, radiator connections, simple controls and simplified piping account for the low initial cost of unit heating systems. A unit heater weighing approximately 100 pounds has a heating capacity equivalent to more than a ton of cast iron radition surface or pipe coils.

Fuel costs are proportional to heat distribution. Any waste in heat distribution to areas where it is specifically needed results in an increased cost burden. By providing easy control over heat in any area, unit heaters give a close correlation between performance and requirements for heat and thus effect fuel savings.

Since industrial plant layouts are rarely static . . . and new machines or new manufacturing techniques impose a new set of heating conditions, cost of future alterations in the heating system must be seriously considered in selecting the heating systems. Here the unit heater offers great advantages, for heat distribution patterns are easy to re-locate or re-direct to meet new comfort requirements. In addition, unit heaters do not form obstacles to the use of any floor space.—*T. F. Hedding, Young Radiator Co.*

# Schoolroom Unit Ventilators

J. E. YORK

Building Service Engineer, Stone & Webster Engineering Corp.

**Unit ventilators may be grouped into the schoolroom type and the industrial model. Design features of the schoolroom type are described. An article on the industrial type appeared in the September issue.**

THE ideal schoolroom type unit ventilator will provide the necessary amount of fresh air per person at all times without drafts in cold weather, or overheating in mild weather.

Because of variations in code requirements in different states, this type of unit ventilator may be required to operate under one of the following conditions during the period that classrooms are in use:

1. Provide all outside air.
2. Provide a varying quantity of outside air with a fixed minimum.
3. Provide a varying quantity of outside air with no fixed minimum.

During the period when the room is not occupied, 100% recirculation of the air is permissible in each case.

Studies by manufacturers of high grade units show that in order to prevent overheating or drafts, the volume of air to be circulated must be such that the internal heat gain may be absorbed with air entering at a temperature not lower than 10F below the desired room temperature.

This quantity will vary from 23 cfm per occupant of elementary grades to 27.5 cfm per occupant of the average high school room.

With these quantities there should be no objectionable drafts. The maximum variation in temperature throughout the occupied area will not exceed 20F, and rooms will not be overheated even if exposed to direct rays of sunlight, as long as the outside temperature is below 60F. In most states, the quantity of air to be circulated is set at 30 cfm per person.

## Capacities

These units range in capacity from 500 to 1,200 cfm standard air to suit rooms of varying occupancy and may be obtained with four different capacity radiators in each size. Table 1 for a 1,200 cfm unit of a standard make shows the final temperatures; total heating surface; the heating surface required for heating the air, and the surplus heating surface which is available at varying outdoor temperatures for offsetting the heat losses from the buildings.

The method of using Table 1 may best be explained by the following example:

To offset the heat losses through walls and windows of a classroom designed for 40 occupants, when outside temperature is 0F, it is necessary to provide 120 sq ft of equivalent direct radiation (EDR). If the state code requires 30 cfm of outside air per person, what size schoolroom type unit ventilator should be furnished?

A unit having a capacity of 1,200 cfm of standard air will be required which is the rated capacity of the unit given in Table 1.

The table shows that to heat this air from 0F to 70F will require 380 sq ft EDR.

If to this the 120 sq ft EDR required for losses through walls and windows is added, the total required capacity is 500 sq ft EDR. Model 2 has a total capacity at 0F of 439 sq ft EDR which is not sufficient, but Model 1 has a capacity of 526 sq ft EDR which is slightly in excess of requirements. The larger unit should be used.

The air leaving this unit will have a temperature of 97F.

If the outside temperature should drop to —10F the table indicates that Model 1 has a total capacity of 548 sq ft EDR of which 434 sq ft EDR is required for heating outside air from —10F to 70F, leaving a surplus of 114 sq ft EDR which may be used to offset losses through walls and windows.

Under these conditions these losses would have increased to approximately 137 sq ft EDR which is in excess of the capacity of the unit.

If a temperature of —10F occurs only at rare intervals and lasts for only a few hours, the installation

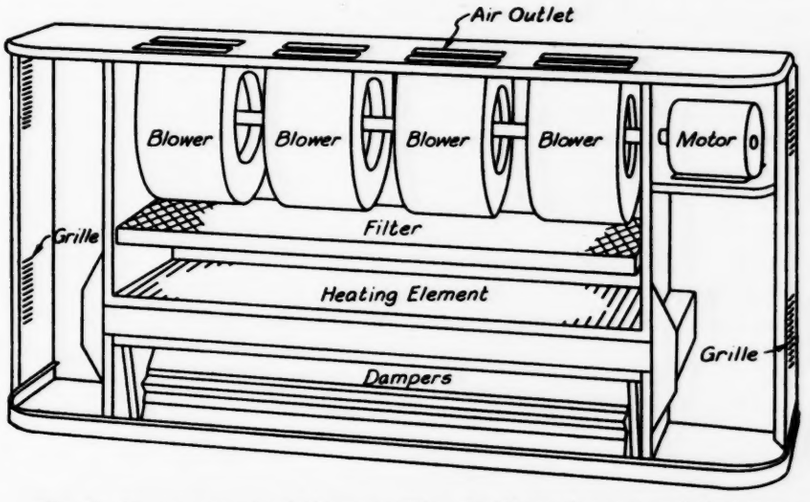



**Fig. 1. Arrangement of blowers, filter, heating element and dampers in one model.**

**Table 1 — Ratings for School Room Unit, 100 Per Cent Outdoor Air**

| Model No. | Outside Temperature in F | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | —30 | —20 | —10 | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 |
| | Final Temperature in °F | | | | | | | | | | |
| 1 | 80 | 86 | 91 | 97 | 102 | 108 | 114 | 119 | 125 | 130 | 136 |
| 2 | 62 | 68 | 75 | 81 | 87 | 93 | 100 | 106 | 112 | 119 | 125 |
| 3 | 36 | 43 | 51 | 58 | 65 | 73 | 80 | 87 | 94 | 102 | 109 |
| 4 | 22 | 30 | 38 | 46 | 53 | 61 | 69 | 77 | 85 | 93 | 101 |
| | Total EDR in Sq Ft | | | | | | | | | | |
| 1 | 596 | 575 | 548 | 526 | 499 | 477 | 455 | 428 | 407 | 380 | 358 |
| 2 | 499 | 476 | 461 | 439 | 418 | 396 | 380 | 358 | 336 | 320 | 298 |
| 3 | 358 | 342 | 331 | 315 | 298 | 288 | 272 | 255 | 239 | 228 | 212 |
| 4 | 281 | 270 | 258 | 247 | 236 | 224 | 213 | 202 | 191 | 179 | 168 |
| | Heat for Air to 70F, EDR in Sq Ft | | | | | | | | | | |
| 1, 2, 3, 4 | 542 | 488 | 434 | 380 | 325 | 271 | 218 | 163 | 109 | 54 | 0 |
| | Surplus EDR in Sq Ft | | | | | | | | | | |
| 1 | 54 | 87 | 114 | 146 | 174 | 206 | 237 | 265 | 298 | 326 | 358 |
| 2 | —43 | —12 | 27 | 59 | 93 | 125 | 162 | 195 | 227 | 266 | 298 |
| 3 | —184 | —146 | —103 | —65 | —27 | 17 | 54 | 92 | 130 | 174 | 212 |
| 4 | —261 | —218 | —176 | —133 | —89 | —47 | —5 | 39 | 82 | 125 | 168 |

Data for one manufacturer's units. Rated air capacity of unit is 1560 cfm as determined by the ASHVE anemometer method or 1200 cfm as found by the ASHVE code for testing and rating steam unit ventilators.

of a unit with a larger amount of heating surface or supplementary heating surface should not be necessary for general comfort.

## Construction

This type of unit ventilator is commonly designed for installation under a classroom window and it is therefore essential that it shall be of attractive appearance, easily serviced and of rugged construction.

Casings are usually constructed of furniture steel finished to suit the rooms in which the units are to be located, and are available in both recessed and free-standing models or, if required, in horizontal ceiling type models.

Fig. 1 and 2 show the construction of one make of this type of unit. The ventilator is of draw-through type with the fans above the heating surface and the motor at one end in a separate compartment outside the heated air stream.

Three dampers are provided, one for controlling the return air, and two for the fresh air. The fresh air dampers are interlocked and control the amount of fresh air by-passing or passing through the heating surface as required to maintain proper temperature of air leaving the unit. A filter can be installed between the heating surface and the fan to filter air supplied to the room.

The fan has forward pitched blades to provide high outlet velocity of the air discharged vertically toward the ceiling.

The construction of a manual control is shown in Fig. 3. A fresh-air connection through the outside wall and a return air grille at the front of the unit, both of which are located near the floor, provide either fresh or recirculated air for the unit in accordance with the damper setting. A readily serviced filter can be installed to clean both the fresh air and the recirculated air, if so desired.

Fans are of the multiblade type designed to deliver

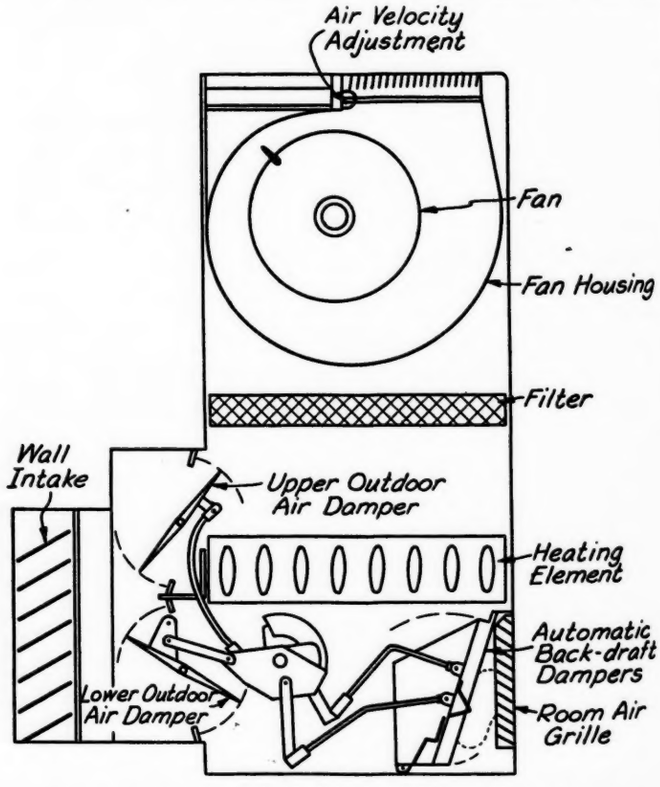



Fig. 2. Section through one type of ventilator showing air controls.

the specified amount of air with a minimum of noise and power consumption. The noise level should not exceed 45 decibels. The fan wheels are mounted on a single shaft driven by a direct connected variable speed motor with a maximum speed of about 750 rpm.

The heating surface is located on the discharge side of the fan and is of the nonfreeze type. Steam and return connections are concealed in the casing. A combined fresh air and recirculated air damper may be set to control the amount of fresh or recirculated air supplied to the unit.

## Controls

For operating conditions 1 and 2, automatic control is recommended, but where funds for automatic control are not available, manual control may be used. For operating condition 3, manual control is not satisfactory.

Manual control equipment for use with conditions 1 and 2 is shown in Fig. 3 and the operation is as follows:

Two cams mounted on a single shaft, which may be rotated through an angle slightly under 360° by a handle located on the outside of the casing, operate the damper and a self-closing steam valve.

The sequence of operation for condition 1 is as follows:

With the handle in the extreme position, the steam valve is wide open and the damper is positioned to allow 100% recirculation of the room air.

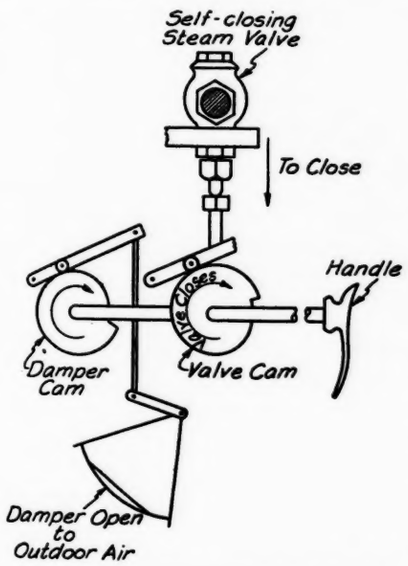



Fig. 3. One form of manual control.

Turning the handle to the right will first close the damper to the room to outside air air and open it while the steam valve remains wide open, and then it will gradually close the steam valve while the position of the damper remains unchanged. This provides 100% fresh air for the occupants of the room and permits control of the temperature of the air supplied to the room.

Automatic control may be either of the pneumatic or electric type.

The former is simpler and is more commonly used.

Pneumatic control for conditions 1, 2 and 3 is similar and only minor changes are required to switch from one to any other if core requirements should change.

Arrangement of the control is as shown in Fig. 4 and the operation for condition 2 in a room that is to be maintained at 70F is described.

When the temperature of the room is below 67F,

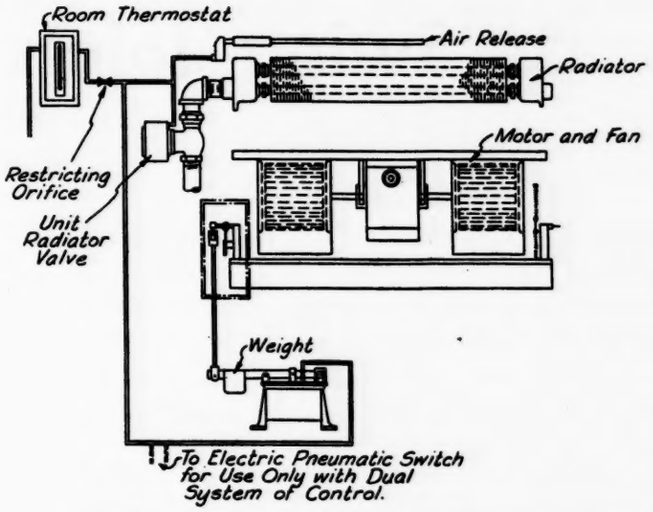



Fig. 4. Pneumatic control used by one ventilator manufacturer.

the steam supply to the heater will be wide open, the damper is held closed to outside air, and 100% wide open to recirculated room air, by means of a counterweight.

As the room temperature rises to 67F, the damper opens to the minimum outdoor air position for which the mechanism is set.

At 68F, if there is direct radiation in the room to supplement the unit ventilator, the steam supply for these radiators is automatically closed.

At 69F the steam supply valve on the unit ventilator starts to close and at 70F is completely closed.

If the room temperature goes above 70F, the outdoor air inlet damper again starts moving to increase the quantity of outdoor air and reduce the quantity of room air. This action continues on a rising room temperature until the damper reaches a full open position when all the air in circulation is taken from outdoors.

If the temperature of the air discharged from the unit drops below the desired minimum (60F or above), a thermostatic element, called a leakstat, installed above the heating unit, will bleed sufficient air from the control line to open the radiator valve sufficiently to maintain the minimum desired air temperature. With a falling room temperature the cycle is reversed.

Where a dual system of temperature control is used, an electric pneumatic switch should be provided to close the outside air damper when the fan motor stops.

Electric control equipment may be installed in place of pneumatic control, if desired. The sequence of operations is similar but the equipment is somewhat more complicated.

## Vent Outlets

The air supplied to the classrooms may be exhausted either through a vent duct in the adjacent cloakroom or through grilles in the bottom of individual lockers and out at the top to a common vent flue, or it may be vented through louvers in the classroom door to the corridor and out through a common flue serving several rooms.

# Do Swing Joints Swivel or Bend?

T. W. REYNOLDS

**Whether swing joints swivel on their pipe fittings or bend on their spring pieces, Mr. Reynolds' analysis presents a practical approach to the solving of layout and field problems in piping connections.**

DO swing joints swivel on their pipe fittings or bend on their spring pieces? That is the question. The answers as received from leading contractors of long experience have been contradictory and varied. The writer has been surprised to find this uncertainty and lack of agreement among experts and feels that had he been an old time contractor he would have long since rigged up a few types of swing joints, using his shop as a laboratory, and have quickly determined the facts.

If swing joints do not swivel or turn on their fittings or threads (and should they do so they would leak, according to some), then why do we continue to call for them in specifications, spend drafting time on nice details, as well as money and labor in the field, just to take up space and add the considerable resistance or pressure drop of their fittings to the flow of steam? Regardless of what a swing or swivel joint does or does not do, there seems to be no other part of piping design where so much misconception and confusion exists on the part of the average layout man, who has, as a rule, but little time to think it all out carefully.

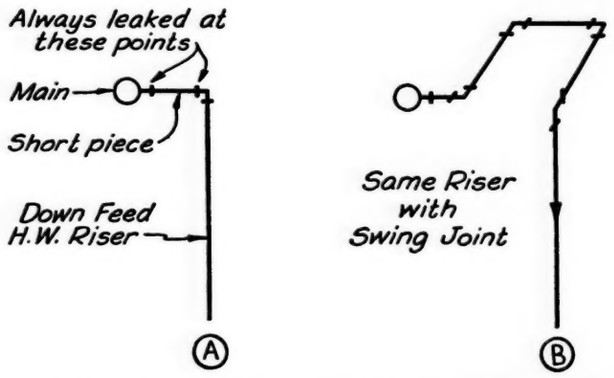



Fig. 1. A leaky hot water riser and the correction applied.

The writer feels that swivel joints are in general unnecessary on low pressure steam piping; that if they turn they ultimately do leak, though only when heating of the piping is intermittent and frequent, and thermal expansion is not within reasonable limits of say one-half inch. For greater expansion than this we usually buy regular patented expansion joints. He feels further that the spring pieces must be flexible, that is, of small enough diameter and long enough to bend (ever longer as the diameter increases); that the spring pieces being less resistant usually do bend and take care of the thrust or expansion, but when they cannot bend sufficiently, only then do the fittings turn a bit on their threads to complete the necessary expansion. In a further analysis, when the pipe is welded rather than threaded we no longer have swivels and must depend upon the inherent flexibility of the pipe.

Fittings rust tight and should not be unduly disturbed, but fittings made up to the proper number of threads do have enough threads left even when a few of the threads are defective to still be tight when turned slightly, especially so when they are expanded under heat. A further point is that the longer the spring piece, the less the angle required for bending or the less the turn of the fitting on threads to make for a given linear expansion.

A contractor told the writer that on one job he left marks on swing fittings, but could not detect any movement. On another job, with a long main in a residence with quick pick up (due to liberal size of main, good venting and oversize boiler) the end of the main certainly moved, but any turn in the branch fittings could not be observed and there were no leaks. Another contractor told of an installation where the specifications called for the pipe joints to be made up with graphite and oil so that the threads would be lubricated and turn. So they did—and they leaked!

The matter of a downfeed riser which leaked so often after installation (see "A" in Fig. 1) as to disgust one plumbing contractor was corrected by a friendly heating contractor called in, as shown in "B" of Fig. 1. Possibly a hot water riser is more subject to leak than a steam riser; in any event the correction in this case by way of swing joint did not prove its necessity. What is more likely is that one or more of the pipe lengths in the swing joint were long enough for the necessary flexibility.

This matter of flexibility is an important thing, so says one steamfitter, as he roughly sketched the way he provides sufficient length for flexibility when the main is run rather close to the risers. As shown in "B" of Fig. 2, he simply starts the branch away from

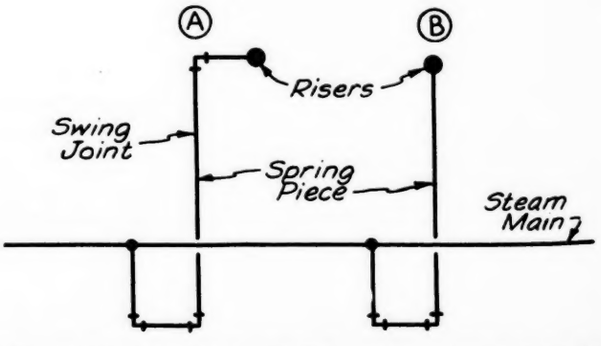



Fig. 2. How to obtain flexible spring pieces when the main and risers are rather close together.

the riser and then turns it back to the riser. If a swing joint were desired he would have made an additional turn, as shown, at "A" in the same sketch.

The expansion force in a branch spring piece to a riser is soon realized when a union is inserted in its run, for the contractor will be called back every few days just to make the union tight again. The two faces of the union will come apart. Such trouble can be avoided by substituting a right and left coupling, though there is no need for either a union or coupling if the main is run first and the risers installed later.

Referring again to "B" in Fig. 2, the pipe from the riser to the first ell is supposed to be graded down towards the ell. Recommended practice and details call for this, so how is it done? The answer is it isn't done, or at least seldom so. Larger sizes of pipe can be used, or pitched ells can be bought in normal times and possibly kept segregated from the ordinary ells, but their pitch is insufficient for recommendations. Someone will say the pitch can be obtained and by cutting a crooked thread. So it can be, though with doubled labor, and if the space is confined, and it usually is, there may be insufficient room in which to

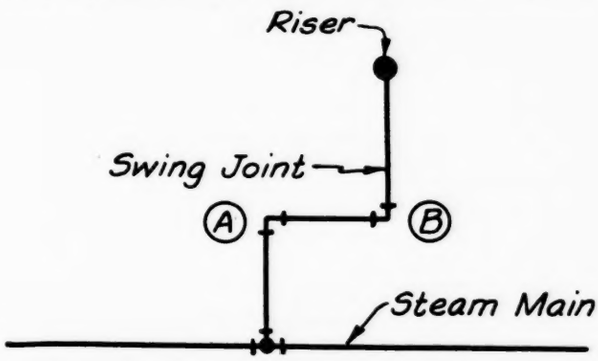



Fig. 3. The way swing joints to risers are usually shown on drawings.

swing the end of the pipe through its planetary motion as the pipe is turned in the fitting.

Fig. 3 shows the way we usually draw in the runouts to risers on our plans. This would seem to prove the necessity for swing joints in this case. Yes, such joints are often necessary, but not usually for the purpose discussed. They are necessary where the risers are installed and the main then run with its tees for runouts quickly approximated for position. As a consequence, the ells at the main and riser do not line up with one another, so the piece of pipe from "A" to "B" is required to bridge the gap.

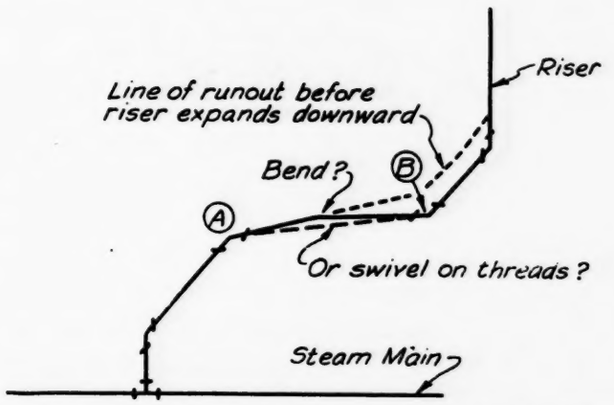



Fig. 4. What happens to a swing joint as the riser expands downward.

Another point is, that where the remaining two pieces of pipe are reasonably short, we can regard them as nipples, in which case the specified grade of the runout can be easily obtained by pitch from "A" to "B". In this case the pitch must be great enough so that sufficient grade is left as the riser expands downward, the downward expansion either turning the ell at "B" in Fig. 4 to grade down toward "A", or bending the pipe between these points as shown. Pitch can also be obtained from "A" back to the tee simply by turning the tee at an angle back towards you as you view the sketch.

Depicting in an exaggerated form the action resulting from alternate assumptions—that a riser and a main are fixed and cannot give one iota, and also that they can—just what is it that happens to various forms of runouts when a steam main expands thermally from position "A" to position "B" (see Fig. 5). If the fittings swivel on their threads, there is only one runout that can satisfy the increased length of runout required without bending of the pipe or deflection of the main or riser from their fixed positions, and that is "L", the runout as shown with the double ells. Actually what probably happens is that the slight amount of normal expansion is taken up in a combination of ways, by slight give of the riser and main toward one another, by slight bend of the runout, and possibly by some slight contribution of thermal expansion in the runout increasing its own length.

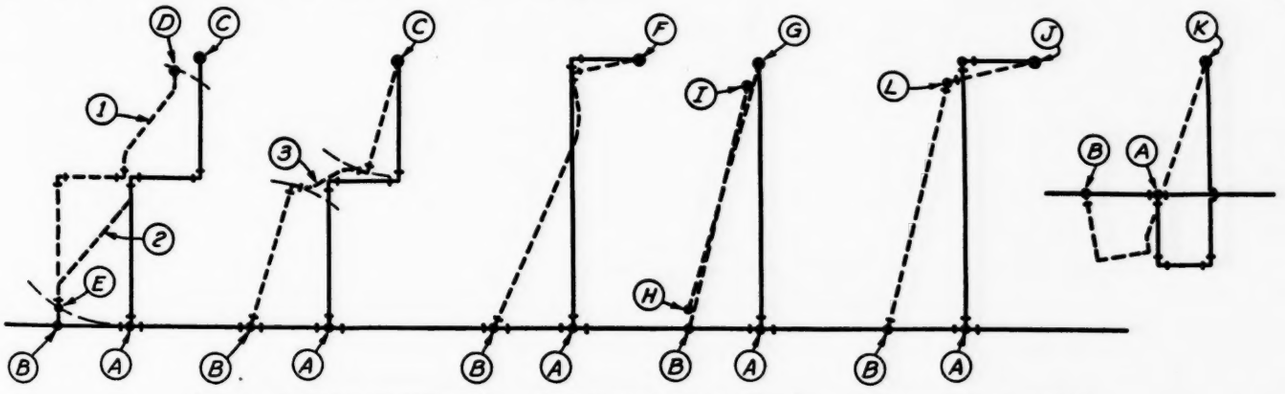



Fig. 5. Possible stresses of various types of runout when a steam main expands.

# A Factory in a Railway Tunnel

S. C. MOUNT

**The accompanying article describes the wartime use of 5 miles of the London subway system for a factory. To make this possible, it was equipped with full air conditioning and other modern conveniences. The description is almost a full abstract of a paper by Mr. Mount presented before the January 1946 meeting of the Institution of Heating and Ventilating Engineers of Great Britain of which the author is a member. The paper is presented here by permission and through the courtesy of the British Institution.**

THE length of the single tunnel is 8,500 yards (over 4¾ miles) and includes three stations. A portion of the line is near the surface, being in so-called "cut and cover" but the remainder is at a depth from 50 to 80 ft below the surface.

The majority of the factory, therefore, is in what might be thought at first sight to be rather cramped quarters, namely a 12 ft diameter tunnel, though the three station areas were most useful for housing some of the special processes. But from the diagrammatic section, Fig. 1, it will be seen that in fact there was plenty of room. In all 300,000 sq ft of floor space was available. The cube was about 3,000,000 cu ft, from which figure an approximation to the ventilation problem can be made, allowing six air changes per hour.

For convenience the story of equipment of the factory is divided into three sections: Civil engineering; electrical engineering; ventilation and cooling.

## Civil Engineering

By reference to Fig. 1 it will be seen that the level at which the floor was put in was very important. It was necessary to select this position so that maximum head-room and floor space in the factory was retained while maintaining sufficient space for the underfloor ducts, as this was the only place available for air delivery in each section of the factory. The ceiling height on the center line is 9 ft 3 in. The construction of the floor can be seen; two walls were built up on the normal concrete foundation for sleepers and on these walls were laid the reinforced concrete slabs forming the floor. Where the 18-in. gauge track occurs, the slab was lowered to carry the rails, which were then floated in to form a floor upon which one could walk in comfort.

All the services on the cable racks will be noticed. On the righthand side the lighting feeder, the compressed air main, telephone cable, cutting fluid piped to the machines, and the water mains to feed drinking fountains and so on. On the left is the H. T. ring main, the bus-bar feeders and emergency lighting cable.

Fig. 2 shows the bare tube with the dwarf wall built ready to receive the floor slabs, and indicates the connection of central main duct to the delivery points.

*Lavatories* were equipped with water-borne sanitation despite the fact that they are at least 60 ft below ground. These lavatory blocks were 50 ft long and located at positions in the tunnels where connection could be made to main drainage above. These connections were by means of a 10-in. bore hole; this bore was lined with a steel tube and the 4-in. sewage ejection pipe was passed up it. The annular space between the 4-in. and 10-in. pipes was used for ventilation. A separate centrifugal fan was installed at the base of the bore hole so that air drawn from the factory could be passed through the lavatory block and evacuated to the surface independently of the main air conditioning system.

*Entrances and Exits.* These were provided at each of the three stations and at two intermediate points, where special shafts had been sunk to ensure that no

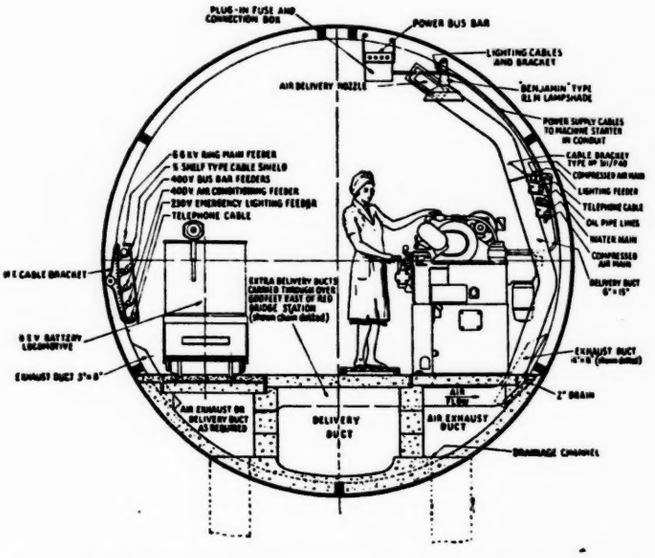

PLUG-IN FUSE AND CONNECTION BOX
POWER BUS BAR
LIGHTING CABLES AND BRACKET
AIR DELIVERY NOZZLE
BENJAMIN TYPE 8LN LAMPSHADE
POWER SUPPLY CABLES TO MACHINE STARTER IN CONDUIT
6.6 KV RING MAIN FEEDER
5 SHELF TYPE CABLE SHELF
400V BUS BAR FEEDERS
400V AIR CONDITIONING FEEDER
230V EMERGENCY LIGHTING FEEDER
TELEPHONE CABLE
CABLE BRACKET TYPE OF 36/7-00
COMPRESSED AIR MAIN
LIGHTING FEEDER
TELEPHONE CABLE
OIL PIPE LINES
WATER MAIN
COMPRESSED AIR MAIN
DELIVERY DUCT 6'-0" x 15"
EXTRA DELIVERY DUCTS CARRIED THROUGH DUCT GODLEY EAST OF OLD MUDEK STATION
6 KV BATTERY LOCOMOTIVE
EXHAUST DUCT 3'-0" x 8"
EXHAUST DUCT 4'-0" x 8"
2" DRAIN
AIR EXHAUST OR DELIVERY DUCT AS REQUIRED
DELIVERY DUCT
AIR EXHAUST DUCT
DRAINAGE CHANNEL

**Fig. 1. Section of tunnel showing electric and other services.**

operative had more than about ¼ mile to travel in the tunnel to his or her machine. At two stations the normal escalators were installed to facilitate the movement of personnel and in addition hoists were provided to deal with raw materials entering and finished parts leaving. At the two places referred to above, lifts were installed in the 15-ft shafts, and they carried operatives and materials. The trucks used on the narrow gauge track in the factory were capable of being run into the lifts to avoid more than one handling. At the third station the ticket hall will be under the roundabout with stairways connecting it to the pavements on all sides. These stairways were used for entrance to the factory at this point, while at other places direct connection was made at road level and gate-keeper's offices, cloak rooms, first-aid rooms, were all incorporated in the surface buildings.

*Canteens.* Redbridge was selected as the site for the main canteen. This building could seat 650 persons, and in addition cooking for outlying canteens was done here with arrangements for conveying the cooked food in insulated containers. There were three of these smaller canteens each seating 400.

## Electrical Engineering

From a survey of the engineering requirements of the factory, it was decided to provide for a load of 5,000 kva and to install two alternative sources of supply. One source was from the Greenwich generating station entering through the existing Leytonstone substation, near the west end of the factory reservation, and the second from Ilford Corporation. In both cases the H.T. ring main in the factory was energised at 6,600 volts, 3-phase, 50 cycles, and the necessary switchgear was provided to make possible a change over at short notice if this should become necessary. Normally the load was provided by each supply for a period in turns.

*Substations.* The load was spread over the 2½ miles of factory length by equipping substations at four locations, from which points the L.T. bus-bars along the length of the factory could be fed by a standard 400 volts, 3-phase supply. A typical substation comprises ironclad compound-filled high-tension switchgear, oil-immersed static transformers having automatic voltage regulators with earthed neutral. The L.T. side of each transformer was connected through iron-clad oil immersed circuit breakers to the main distribution boards located at factory level.

The location of the substations brought the centres of supply near to the principal load centres which included the large air-conditioning plants. The largest units of these plants were the 170-hp high-torque low-current design of motors for the refrigeration compressors. These motors were arranged for direct-to-line starting.

*Other Supplies.* The production machines were installed almost continuously throughout the 5 miles of tunnels and as each was driven by its own motor, it was necessary to provide means for connecting to the electric mains at very frequent intervals. The arrangements are illustrated on the front cover of this issue. The continuous bus-bars can be seen at the top of the circular tube lining and also the points tapped off to each machine. The L.T. cables in the racks at the side were connected to these bus-bars at intervals in order to maintain pressure.

The following list of uses for which electricity was required will give an idea of the variety of the undertaking. About 60 motors used in the air-conditioning plants are not included here as they are dealt with in the next section.

Sewage ejector pumps and fans at each lavatory.
Compressors for charging compressed-air mains.
Factory power and lighting distribution boards.
66 bells of the warning system.
130 instruments on the automatic telephone system.
Lifts, escalators and machinery hoists.
Heating and ventilating in first-aid and cloak rooms.
Lighting and heating in fire stations and other auxiliary offices.

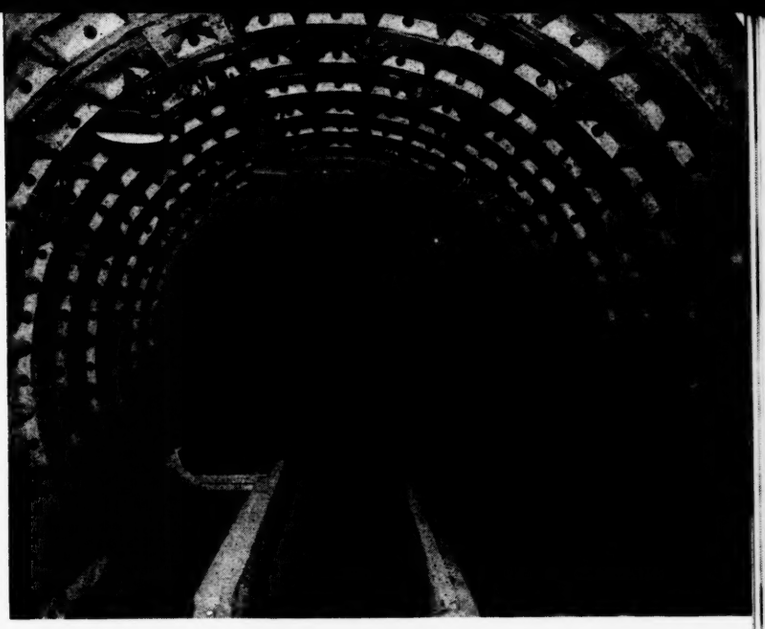


Fig. 2. Bare tunnel.

Special battery-charging installation for battery-operated locomotives.

*Lighting.* Much thought was given to the lighting of the factory as it was, of course, desirable to ensure maximum comfort in this connection. The installation included some 6,000 lamps and the circuits were arranged with suitable safeguards having regard to the underground nature of the factory. First, the majority of the lamps were in a row, each in a dispersive-type reflector, suspended from the tunnel lining and providing a minimum intensity of 25-ft candles at the working plane. The sub-circuit wiring was interweaved so that if any switch was opened, alternate lamps remained alight. In addition, in case of an interruption of the total supply by enemy action, a special automatic device was employed. By connecting every tenth lamp throughout the tunnels to independent circuits normally fed from the a. c. supply, and by-passing these circuits through automatic contactors, then in the event of a total interruption of supply, this 10 per cent lighting would be energised by a battery and this would be sufficient lighting for the emergency.

## Ventilation and Cooling

If anyone would like to calculate the heat gains or losses from this unusual factory, it should be remem-

Fig. 3. Air conditioning plants at factory level.

bered that not only are there no windows or large area of roof glazing but the "walls" are in heavy cast-iron segments immediately surrounded by an immense amount of London clay. So that the thermal capacity is enormous. It was evident, therefore, that until the tunnel lining was warmed up a little there was a danger of condensation. Then there was likely to be a period during which some of the cooling would be done by conduction outwards through the surrounding clay. In fact this helped quite a lot the first year, but thereafter, when the surrounding clay became more and more stored with heat, it was upon the refrigeration plant that the works depended for its even temperature, as well as for its steady relative humidity. There would seem to be no doubt that the refrigeration plants were essential in this case.

At the time the general design of the air-conditioning plant was decided upon, the production layout and, therefore, the distribution of heat-producing machinery was not available. It was decided, therefore, in conjunction with the factory planning engineers, to make the following assumptions:—

(*a*) The controlled factory temperature to be 65F.
(*b*) The production machinery to be taken as 2,000 hp evenly distributed.
(*c*) Load factor to be as for continuous shifts throughout the 24 hours.
(*d*) The number of employes expected was 2,000.
(*e*) Lighting 350 kw evenly distributed.

*Fresh-air delivery*, as stated above, an early decision introduced the design of underfloor duct already shown, and in consequence the factory was divided into four main sections, the sizes being such that these underfloor ducts could distribute the necessary volume.

The plants had of necessity to be divided into two equal parts to serve each road. To give more space they were placed on the station, Fig. 3, where 22-ft diameter instead of 12-ft diameter tunnels were the normal construction. It was also found convenient to install two plants in each tunnel, making four plants at each site; and these pairs were placed with the fans towards the center, so that the recirculation dampers faced down the section of tunnel served by each fan. The final design was for 18,000 cfm centrifugal fans which in many cases operated against a water gauge of 4 in.

Each of the four plants at each site had the usual air-conditioning equipment with chill-water spray chamber, eliminator plates, 84 kw heater battery to correct the temperature of the saturated air, and finally the fan to deliver by the underfloor ducts to points every 60 ft along the tunnels. The fresh-air inlet and recirculation damper shared the entry to the suction side of the plant, the proportion of air in each case being automatically set according to the outdoor wet bulb. Each plant had its own pump to deliver water to its spray nozzles, while each pair of plants had one pump to raise the water to the surface where the evaporators were placed.

After careful experiment the design of the branch delivery duct was settled. As will be seen in Fig. 4, each of the ducts which were set at 60 ft intervals in the tunnels and carried 600 cfm, had a nozzle facing each way axially along the tunnel at about 8 ft above the floor. The arrangement proved most successful as the fresh air was thrown out to 30 ft in such a way that the operatives never complained of discomfort, although the temperature was at a minimum of 50F. With this temperature for the conditioned air it was possible to maintain an ambient temperature of 65F in the working spaces.

The air delivered by these branch ducts found its way back to the air-conditioning plants for recirculating picking up heat on the way. But at no point was the speed more than 3 miles an hour, so that draught complaints were not often met.

*Exhaust System.* In order to economize as much as possible with the refrigeration plant, recirculation was adopted at times when the wet-bulb temperature of the outer air was outside the range 50 to 56F. The proportions admitted under automatic damper control varied from 25 to 75% recirculated air. The exhaust fans were installed in pairs handling about 10,000 cfm, each fan against a static resistance of 2.5 in. water gauge at speeds of the order of 650 rpm. The lavatory

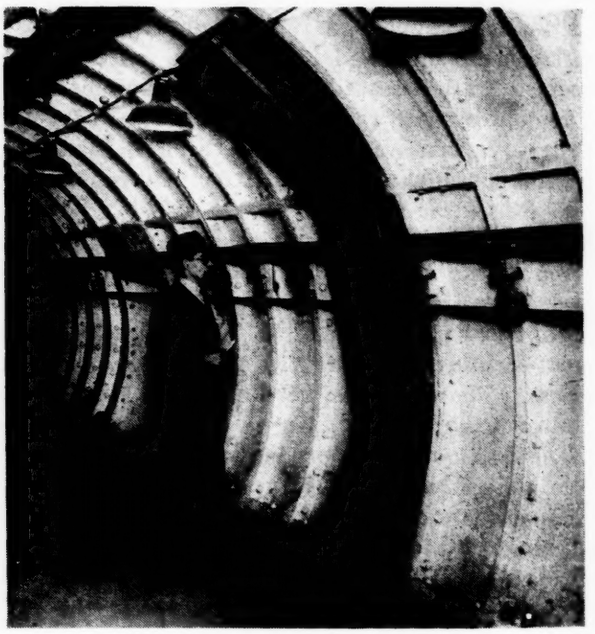


Fig. 4. Air delivery branch duct.

fans also ran to exhaust and remove from circuit a small amount of air so that it was necessary carefully to adjust these several factors, and as a result no appreciable interchange could be noticed at the factory entrances. This was an important feature for there would have been a difficulty to maintain the steady relative humidity throughout the factory had the conditioned air escaped in any quantity to be replaced by the unconditioned outer air.

*Refrigeration Plants.* Owing to limited space below ground, it was necessary to house the refrigeration compressors, the condenser, and the evaporators in blast- and splinter-proof buildings at the surface. After consideration of all other available refrigerants $CO_2$ was finally selected; one important reason was that after the war such plant was sure to be needed

for merchant shipping and $CO_2$ is, of course, the generally accepted refrigerant for this purpose.

There were two compressors at each site, each driven by 170 hp squirrel-cage motor designed for direct-to-line starting, which simplified considerably the switchgear required. This was the only item in the whole plant that was not arranged for automatic starting and stopping. Instead of the elaborate control gear that would have been needed, there were installed a pair of indicator lamps actuated by the outside air conditions, and these gave to the patrolling attendants a definite indication as to whether refrigeration was or was not called for at any time.

The typical equipment of one of the refrigerating plants is (*a*) two compressors dealing together with 2,223,000 Btu each driven by 170 hp motor through multiple V-rope belts. The compressor is fitted with a duty reduction device in four stages; (*b*) a condenser in two sections with suitable cooling water pumps and fans to remove the heat by the evaporation of water; (*c*) an evaporator, or Baudelot cooler, to chill the water passed over its surface. The pump to circulate this chilled water is included among the fresh-air delivery plants discussed in an earlier paragraph.

*Special Processes.* Where these were known about at the time of settling the capacity of plants, it was possible to allow for them in the heat balance. This applied, for instance, to certain fuel pump testing and surface treatment rooms at Redbridge, where the materials used in the processes gave off fumes which had to be exhausted direct to atmosphere to avoid contamination with other parts of the factory. These special exhausts are seen in the photograph, Fig. 5.

Later when a considerable portion of the factory hardening shop, representing a heat addition of some 2,000,000 Btu, had to be moved into the tunnel-factory, it was found necessary to keep this section cool by a separate delivery and extraction of outer air avoiding all interchange with the conditioned air by making a balanced unit of each hardening shop. This was found to be quite satisfactory, though the temperature was, of course, not subject to the same close control as in the factory proper.

*Automatic Controls.* It has been said earlier that the air-conditioning system throughout this underground factory was run under full automatic control with the sole exception of starting and stopping of the refrigeration compressors. This control was accomplished in the following manner.

It is customary to refer to the summer and winter cycle, though in this case reference is made to the wet-bulb temperature of the atmosphere rather than to the season.

For this factory the "winter condition" was when the wet bulb was below 50F. During such time the recirculation damper was opened and the admission of factory air into the conditioning plant helped to maintain the required dew-point condition.

In the intermediate stage, namely when the wet bulb was between 50 and 56F, the recirculation damper was closed and 100% outside air was admitted since it was at the dew-point temperature needed in the factory.

During "summer conditions" the wet bulb of the outside air rose to and above 56F when the recirculation damper was again opened, this time to economize refrigeration, since the outside dry bulb was now at a higher level than the controlled factory temperature.

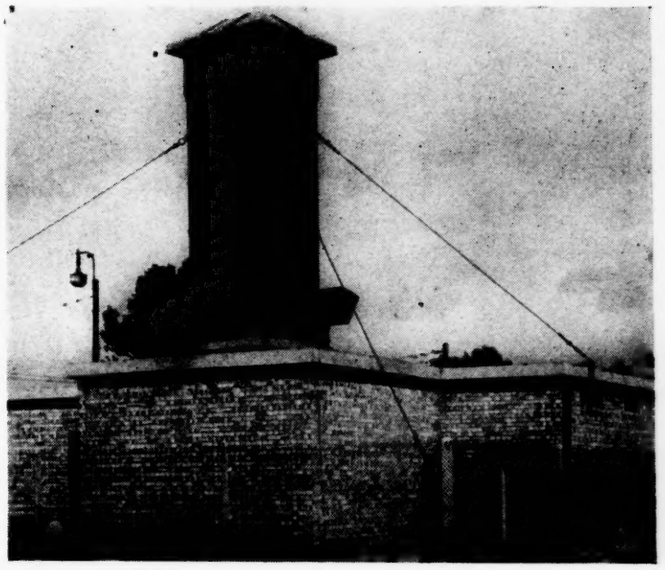
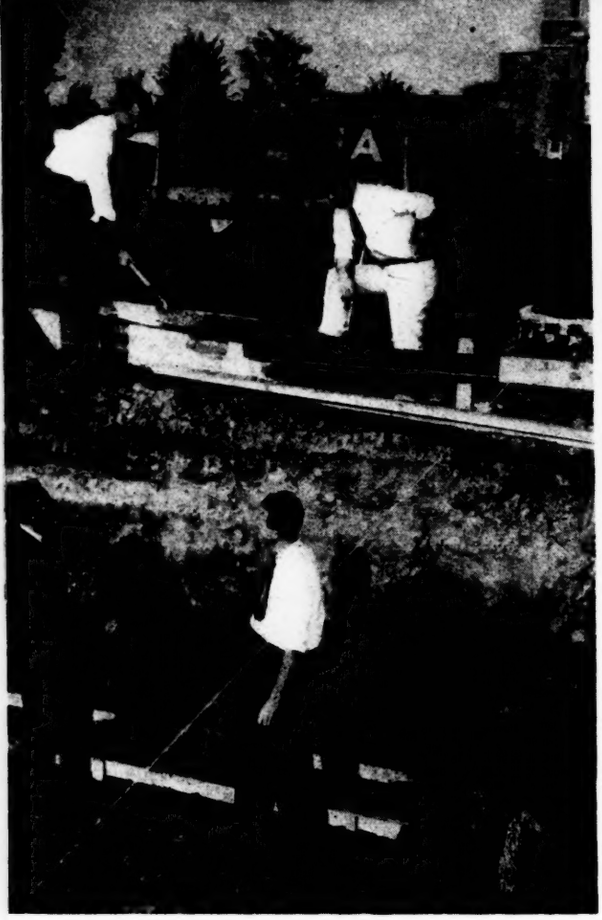


**Fig. 5. External view of housing for refrigeration plants and electric substation showing main air intake raised 30 ft above ground as precaution against enemy gas attack.**

For the *winter cycle*, a modulating remote bulb temperature controller, positions the modulating motor on the recirculation dampers. By this means, and with the fresh-air damper open, just enough recirculation air is admitted to provide the necessary heat to maintain the desired dew-point condition. The reheater is controlled in three sections by a modulation step controller, which in turn is being positioned by a modulating temperature controller located in the recirculation air duct.

*Summer Cycle.* While approaching the intermediate stage mentioned above, the dew-point controller will tend to take less recirculated air and more outside air. When the outside wet-bulb temperature of 50F is reached an on-and-off temperature controller located in the fresh-air intake operates relays and the recirculation is completely closed, and the indicator shows the operator that it is time to prepare for starting up the first refrigeration compressor. At this time too the modulating motorized 3-way mixing valve on the supply to the sprays comes under control of the summer dew-point controller. Thus when the predetermined dewpoint temperature is reached chilled water is introduced into the spray water to effect the necessary lowering of temperature. At this stage in the cycle the plant is using maximum fresh air since the outside wet bulb is lower than that of the recirculation air.

As the outside wet bulb rises above 56F a second on-off temperature controller in the main fresh-air intake operates relays and sets the motorized damper control in motion to reopen the recirculation damper. This is based on the assumption that it is more economical from a refrigeration point-of-view to use recirculated air than the higher temperature fresh air.

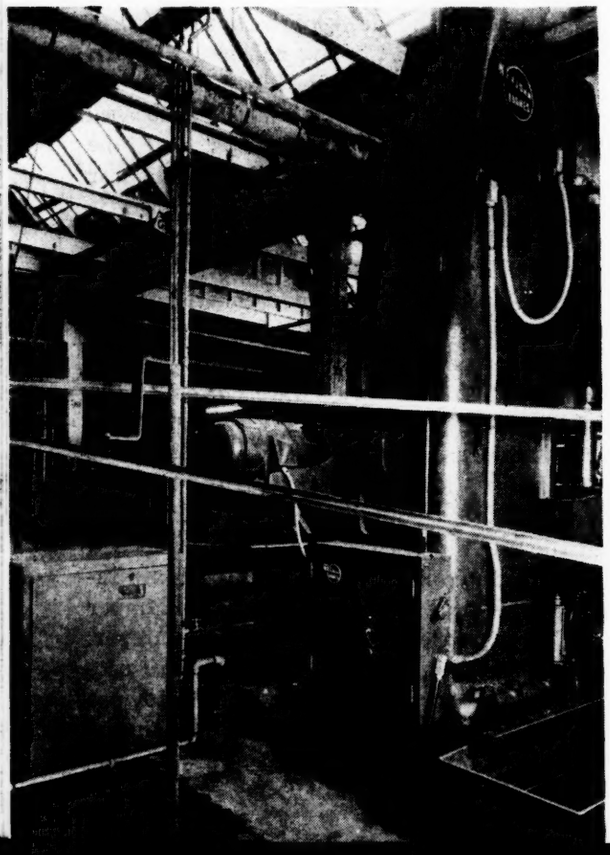


(Above) Shell Oil Co.'s new catalytic cracking plant at Houston, Texas, has a cooling water system with pumping capacity sufficient to supply a city of 150,000 people. This is the first plant of its kind built specifically to use the new micro-spheroidal catalyst in producing civilian gasoline.

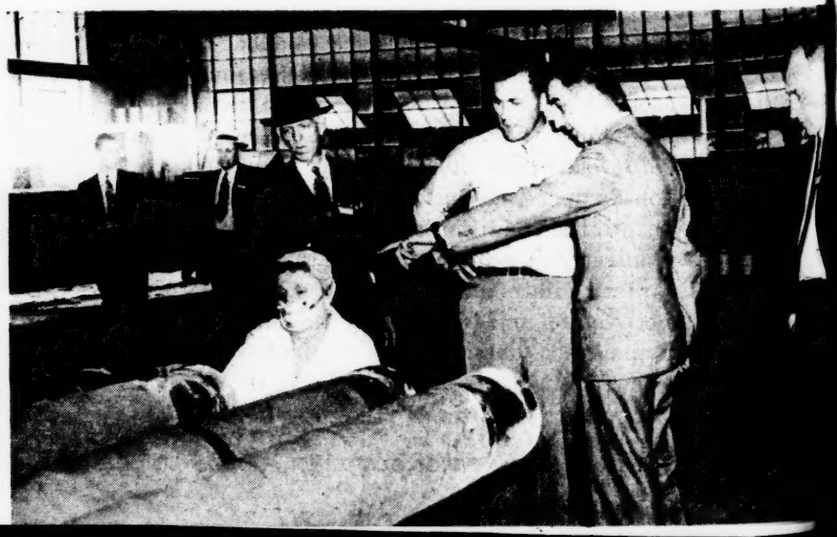
(Left) Construction starts on new warm air heating research house at the University of Illinois as pouring of first concrete is watched by (clockwise from upper left) R. W. Roose, research assistant; Prof. S. Konzo, in charge of research; D. B. Lindsay, architect for the house; and W. H. Scheick, coordinator of the University Small Homes Council.

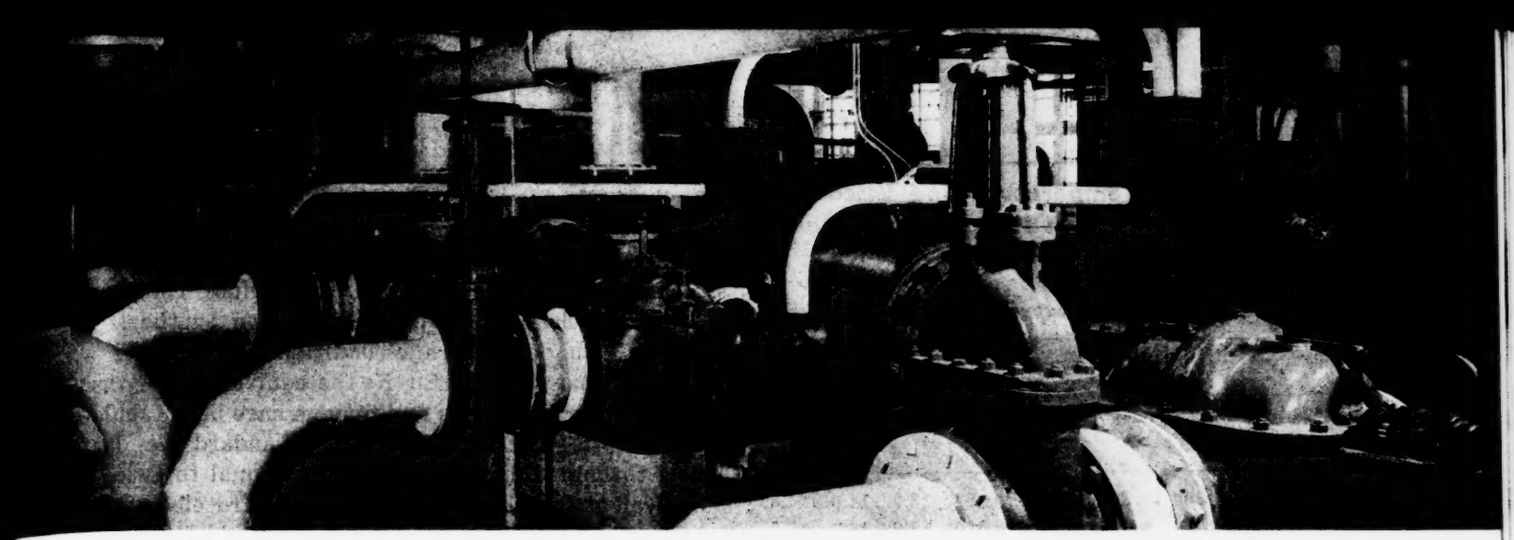
# Picture Paragraphs

(Below) Chrysler PL-300 liquid cooler (left foreground) controls the temperature of cutting oil used with the W. F. and John Barnes 6-spindle boring mill at right and two other machines not visible. Control of cutting oil temperature helps control of tolerance, increases tool life and possibility of performing rapid roughing operations



(Below) Placing watertight packing around preseal of a Ric-wiL Prefabricated pipe unit is demonstrated to power engineers visiting the Ric-wiL plant at Barberton, Ohio, during NAPE Cleveland convention. (Left to right) E. Pandy, Ric-wiL Co.; F. A. Lindstrom, Nicollet Hotel, Minneapolis; Edward F. Juhl, Minneapolis; Gerald A. Mierendorf, A. O. Smith Corp.; Walter Bartel, Ric-wiL Co.; Hilmer Boerke, Wausau, Wis.





# Cold Water Piping in Industrial Plants

## Part 3: Loss of Head Due to Obstructions

**HARRY D. UNWIN**
Mechanical Engineer, Albert Kahn Associated Architects and Engineers, Inc.

**Loss of head due to obstructions and applications of formulas and tables to solution of problems are taken up in this, the third of Mr. Unwin's 4-part series.**

It has been shown by Equation 7 that the loss of head due to friction is $h_f = f \frac{L}{D} \frac{V^2}{2g}$ which occurs when a fluid is flowing through a straight horizontal pipe. In problems dealing with the pressure drop or total loss of head in a piping system, other factors must be taken into consideratlion which influence the conditions of flow and augment the effect due to friction alone, such as the head lost due to entrance, sudden contraction, submerged orifice, sudden enlargement, elbows, ties or other pipe fittings, bends, valves, elevation, velocity, etc. All of these, and the many ramifications of certain items as orifices, bends and sudden change of cross-sectional pipe area, may have an even greater effect upon the total loss of head than that due to pipe friction alone, particularly in systems of short lengths. It is therefore important that the loss due to these miscellaneous special "obstructions" be clearly understood. From Torricelli's equation

$$v = \sqrt{2gh} \quad \text{and} \quad h = \frac{v^2}{2g}$$

In passing, let the word "obstruction" be defined as any occurrence in a pipe line, such as a valve, fitting, change of section, reducer, contraction, etc., which causes the fluid to deviate from its normal course; whether by change of direction, change in velocity, or in any way alters the state of flow. Since the introduction of one or more of such obstructions in an otherwise straight pipe will produce a condition of flow through a short section of the pipe which is out of balance with the normal stream on either side of the obstruction, which in many cases is mathematically indeterminant, it becomes necessary to establish a factor by experiment which will account for this variation of flow through the obstruction. If $K$ represents an experimental constant which will bring the heterogenous flow conditions into balance, then the relationship of the loss of head due to any obstruction may be expressed as

$$h_x = K_x \frac{V^2}{2g} \qquad (13)$$

Since Equation 7 also expresses the loss of head through a section of pipe due to friction, it may be made to equal $h_x$

$$h_x = h_f = K_x \frac{V^2}{2g} = f \frac{L}{D} \frac{V^2}{2g}$$

from which

$$K_x = f \frac{L}{D}$$

and if $L_x$ is the equivalent length of pipe to give the same loss of head as that produced by the obstruction for the same rate of flow, then

$$L_x = \frac{KD}{12f} \qquad (14)$$

Hence when $D$ is in inches $L_x$ is directly proportional to the diameter and inversely proportional to the coefficient of friction which is a function of the velocity, diameter, density and viscosity. We have seen that the density varies only slightly with temperature but that temperature materially influences the viscosity of water. Furthermore, the Reynolds

**Table 3 – Effect of Temperature and Viscosity Upon the Equivalent Length of Pipe for Standard Screwed 6 in. Elbow with K = 0.7**

| Velocity, V, Ft per Sec. | Temperature, F | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 50 | 70 | 100 | 50 | 70 | 100 | 50 | 70 | 100 |
| | Reynolds Number | | | Friction Factor $f$ | | | Equiv. Length $L_x$, Ft | | |
| 1 | 267 | 374 | 530 | 0.027 | 0.025 | 0.024 | 13.0 | 14.0 | 14.6 |
| 3 | 800 | 1125 | 1590 | 0.022 | 0.021 | 0.020 | 15.9 | 16.7 | 17.5 |
| 5 | 1340 | 1870 | 2650 | 0.021 | 0.020 | 0.018 | 16.7 | 17.5 | 18.4 |
| 7 | 1870 | 2620 | 3720 | 0.020 | 0.019 | 0.018 | 17.5 | 18.4 | 19.5 |
| 10 | 2670 | 3740 | 5300 | 0.019 | 0.018 | 0.017 | 18.4 | 19.5 | 20.6 |

number, which combines these several variables affecting the friction factor, is directly proportional to the rate of flow. Table 3 clearly indicates that these factors can theoretically create considerable error in the results under certain combinations. The error due to temperature is approximately 10% and independent of changes in velocity. Also the variation due to velocity is approximately 40% and independent of the temperature. Although the per cent of apparent error is great, the practical effect of a variation of 7.6 ft (maximum for both temperature and velocity) is unimportant when considered as part of a main 760 ft long, for which the error would only be 1.0%. Even if ten elbows were included in the total equivalent length, the difference would only be 10%. In fact it is unlikely that either the minimum or maximum velocity would be considered good design and in general there would not be such a temperature differential as used in the illustration. Hence for a reasonable average set of conditions, a temperature of 70F and a rate of flow of 5 fps should be used, giving an equivalent length of pipe for a 6-in. standard screwed elbow of 17.5 ft.

There seems to be some difference of opinion among engineers and manufacturers regarding reasonable velocities of flow for use in designing water distribution systems. Such ranges of velocity as 2 to 4, 3 to 7, 2 to 5, 5 to 10 fps are found in publications and textbooks. For steel or wrought iron pipe in sizes up to 12-in. diameter, a velocity range of 3 to 10 fps appears to be good average practice, although higher velocities are permitted in the larger sizes of mains. However, it should be remembered that even though the coefficient of friction curve flattens out at high values of the Reynolds number, the friction factor remains almost constant and the loss in head is therefore nearly directly proportional to $V^2$. Thus it is important to keep the velocity down to reasonable limits.

Table 4 lists values of $K$ for various types of valves, fittings and obstructions. These have been modified by the author to satisfy the experimental factors contained therein which are the basic reasons for nonconformity of resistance constants in other tabulations. We have seen from Equation 14 that $L_x$ varies directly with $K$; and from Table 3 that $L_x$ is affected by both temperature and velocity; hence $K$ is dependent on velocity. The conclusion which must naturally be drawn is that many of the factors which mathematically indicate variation with velocity are somehow absorbed and are thus averaged in the final experimental or test results. For this reason, the values of $K$ in Table 4 are adjusted to produce comparable equivalent lengths of pipe in relation to the set of chosen "standard average conditions."

Using these values for $K$, the equivalent lengths of pipe for various valves and fittings have been tabulated in Table 5. The value of $L_x$ for standard tees is for flow through the side outlet and is equal to twice the equivalent length of pipe for a standard elbow of the same size. If flow is through the "run" of the tee, it will be approximately 70% less than the corresponding $L_x$ when flow is out of or into the branch of the tee. It should also be noted that the equivalent resistance of a gate valve fully open is only about 5% of the resistance for the same gate valve when one-half closed. Caution should be exercised in the location of globe valves since they have a resistance of about 33 times that produced by gate valves when fully open.

## Solution of Problems

*Problem 1.* If 70F water flows at the rate of 250 gpm through a 4-in. diameter steel pipe 680 ft long, what will be the loss of head due to friction?

*Solution:* From the equation of flow,

$$Q = AV = 250 \text{ gpm}$$

$$V = \left(\frac{250}{60 \times 7.5}\right) \div \left(\frac{\pi \times 4^2}{144 \times 4}\right) = 6.38 \text{ fps.}$$

Comparing this velocity with Table 1, it is seen to be higher than 0.064 ft per sec which is the critical velocity for 4-in. pipe and 70F water. Hence from Table 2, under 4-in. diameter pipe and opposite a velocity of 6.5 fps (the nearest to 6.38) the loss of head $h$ due to

**Table 4 – Values of K for Various Fittings, Valves, and Obstructions**

$$\left(\text{For use in equation } h = K\frac{V^2}{2g}\right)$$

| Obstruction | K |
|---|---|
| Standard elbow | 0.7 |
| Standard tee | 1.4 |
| Gate valve, fully open | 0.2 |
| Gate valve, half open | 4.0 |
| Globe valve, fully open | 6.5 |
| Angle valve, fully open | 3.5 |
| Swing check valve, fully open | 1.7 |
| Horizontal outlet from tank | 0.5 |
| Sudden contraction | |
| d/D = ¼ | 0.3 |
| d/D = ½ | 0.2 |
| d/D = ¾ | 0.1 |
| Sudden enlargement | |
| d/D = ¼ | 0.7 |
| d/D = ½ | 0.4 |
| d/D = ¾ | 0.1 |

D = larger diameter; d = smaller diameter.

**Table 5 — Equivalent Resistance of Valves and Fittings**

(Based on water at 70F and an average velocity of 5 fps)

| Nominal Pipe Size, Inches | Stand'd Elbow | Stand'd Tee | Gate Valve | | Globe Valve* | Angle Valve* | Swing Check Valve |
|---|---|---|---|---|---|---|---|
| | | | Open | ½ Open | | | |
| | Equivalent Length In Feet | | | | | | |
| ¾ | 1.5 | 3 | 0.4 | 9 | 15 | 8 | 4 |
| 1 | 2.2 | 4 | 0.6 | 13 | 21 | 11 | 6 |
| 1¼ | 3 | 6 | 0.8 | 17 | 27 | 15 | 7 |
| 1½ | 4 | 7 | 1.1 | 21 | 34 | 18 | 9 |
| 2 | 5 | 10 | 1.4 | 29 | 47 | 25 | 12 |
| 2½ | 7 | 13 | 1.9 | 38 | 61 | 33 | 16 |
| 3 | 8 | 17 | 2.4 | 48 | 77 | 42 | 20 |
| 4 | 11 | 22 | 3.2 | 63 | 103 | 55 | 27 |
| 5 | 15 | 29 | 4.2 | 83 | 135 | 73 | 35 |
| 6 | 18 | 35 | 5.0 | 100 | 163 | 87 | 43 |
| 8 | 24 | 48 | 7.0 | 140 | 228 | 123 | 60 |
| 10 | 31 | 62 | 8.8 | 175 | 285 | 153 | 75 |
| 12 | 39 | 78 | 11.0 | 222 | 360 | 195 | 94 |

Note.—Values for welding fittings may be taken as half of standard fittings. Equivalent length of 45° elbow equals one-half standard elbow.

*Valves fully open.

friction is found to be 7.97 feet per hundred feet, or $7.97 \times 6.80 = 54.196$ ft for the 680-ft line.

*Problem 2.* Required to find the diameter of pipe for a flow of 175 gpm if the loss of head due to friction must be limited to 9.0 lb per sq in. and the length of main is 450 ft.

*Solution:* To solve this type of problem, it is necessary to assume a reasonable diameter to obtain a value for the velocity after which the loss of head $h_f$ can be found from Table 2 and the result compared with the given pressure drop.

Convert 9 lb per sq in. to feet of water by multiplying by 2.31, or 20.79 ft, as our maximum.

Assume D = 3 in. Then

$$V = \frac{Q}{2.45 \times D^2} = \frac{175}{2.45 \times 9} = 7.92 \text{ fps.}$$

From Table 2 under D = 3 in. and opposite V = 8.0 we find $h_f = 16.10$ ft per 100 ft. But the problem stated that $h_f$ must not exceed 20.79 ft. Therefore the allowable loss of head per hundred feet must be

$$h_{(allow.)} = \frac{20.79}{4.50} = 4.62 \text{ ft per 100 ft.}$$

Hence the assumed diameter of 3 in. must be too small, since the resultant friction head was found to be 16.10 ft per 100 ft.

Next assume a diameter of 5 in. and repeat the procedure. We find that V = 2.85 fps and from Table 2 as before, $h_f = 1.44$ ft per 100 ft, corresponding to a velocity of 3.0 fps. This is obviously too small.

Now consider a diameter of 4 in. since the previous assumption bracketed the allowable result. The velocity 4.45 and $h_f$ corresponding to V = 4.5 fps is 3.74 which is as close to the allowable friction drop as can be obtained with standard pipe sizes. Hence the correct diameter of pipe to use is 4-in.

*Problem 3.* An 8-in. steel pipe is to be used to convey water from a centrifugal pump to a point 435 feet distant and at an elevation of 25 feet above the pump discharge. The capacity of the pump is 1500 gpm. What is the total pumping head, with suction lift zero?

*Solution:* The total head must include the elevation which is given to the water, the loss of head due to friction, and the velocity head at the terminal point. Hence

$$H = \text{Elev.} + h_f + \frac{V^2}{2g}$$

But

$$V = \frac{Q}{2.45 \times D^2} = \frac{1500}{2.45 \times (8)^2} = 9.57 \text{ fps.}$$

From Table 2, $h_f = 7.26$ ft per 100 ft.

$$\text{The total friction head is } 7.26 + \frac{435}{100} = 31.7 \text{ ft.}$$

$$\text{The velocity head is } \frac{V^2}{2g} \times \frac{(9.57)^2}{2 \times 32.2} = 1.4 \text{ ft.}$$

Therefore H = 25.0 + 31.7 + 1.4 = 58.1 ft.

*Problem 4.* If the 8-in. main in problem 3 contained five 90° elbows, three standard tees and one globe valve open full, what pumping head would be required?

*Solution:* To the 435 feet must be added the equivalent length of the 5 elbows, 3 tees and 1 globe valve. From Table 5 the following equivalents are obtained, bearing in mind that the foregoing analysis explained that the effect of temperature and velocity upon the equivalent lengths of valves and fittings was such as to permit the use of the values in the table.

| | | | |
|---|---|---|---|
| 5 — 90° elbows | @ | 24 | = 120 ft. |
| 3 — std. tees | @ | 48 | = 144 ft. |
| 1 — globe valve | @ | 228 | = 228 ft. |
| Straight pipe | | | = 435 ft. |
| Total $L_x$ | | | = 927 ft. |

Then

$$h_f = 7.26 \times \frac{927}{100} = 67.3 \text{ ft.}$$

and

$$H = 25.0 + 67.3 + 1.4 = 93.7 \text{ ft.}$$

This problem illustrates two important fundamentals in the design of piping systems: (1) under the usual conditions, except in very short runs of main, the velocity head is insignificant with respect to the other losses and can be neglected; and (2) the effect of valves and fittings must never be neglected unless their combined equivalent length is less than 10% of the total head loss. In this case, the effect of the obstructions is to more than double the length of the main.

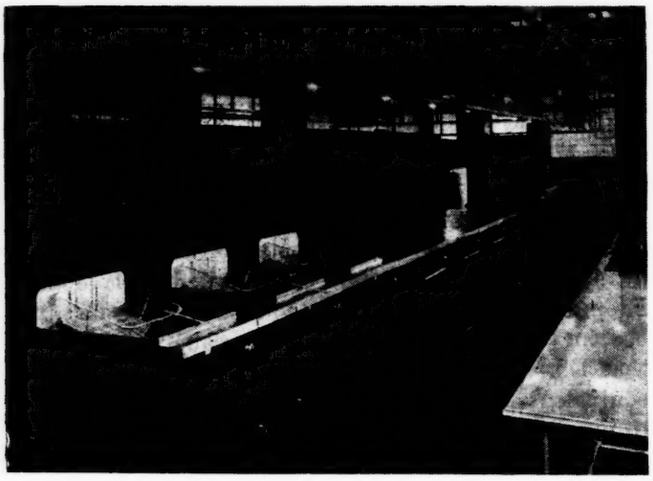
*A discussion of water hammer and piping materials will conclude Mr. Unwin's series next month.*

# Glass Hood for Hospital Kitchen

GALLINGER Municipal Hospital serves as the city hospital for Washington, D. C. A new addition was completed to house one of the most modern gas kitchens in an institution of this type and it embodies a new idea in hood ventilation.

The first thing one notices on entering the spacious kitchen of Gallinger Hospital is that all cooking equipment is installed in the center of the room with plenty of working area all around. The many and varied cooking components required in this large kitchen, which serves from 4,000 to 5,000 meals every twenty-four hours, are installed in two rows back to back with space between the rows and an abundance of light.

Of the many innovations in this kitchen, the most striking is the immense glass hood over this island cooking area which has scientifically designed velocity slots at the edge. These glass hoods have some very

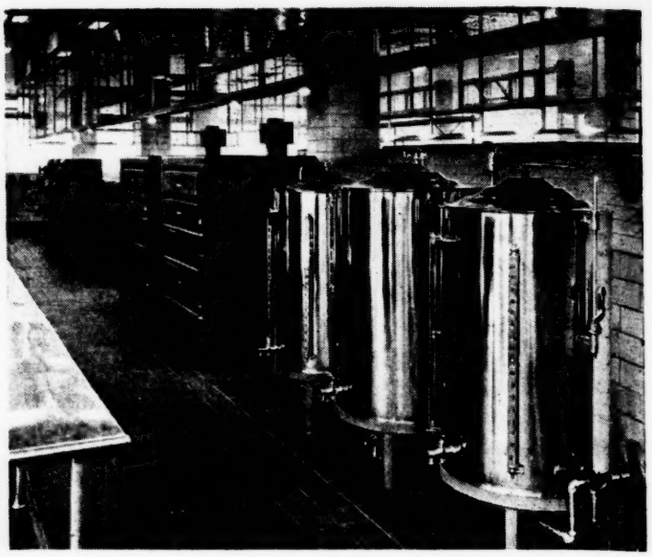


One side of main cooking batteries in center of kitchen served by glass hood.

attractive features. Because the hoods are glass, they must be kept clean to preserve the appearance. The velocity slots are so arranged that excessive fan size is not needed in order to do a thorough job of ventilation and picking up cooking odors and steam.

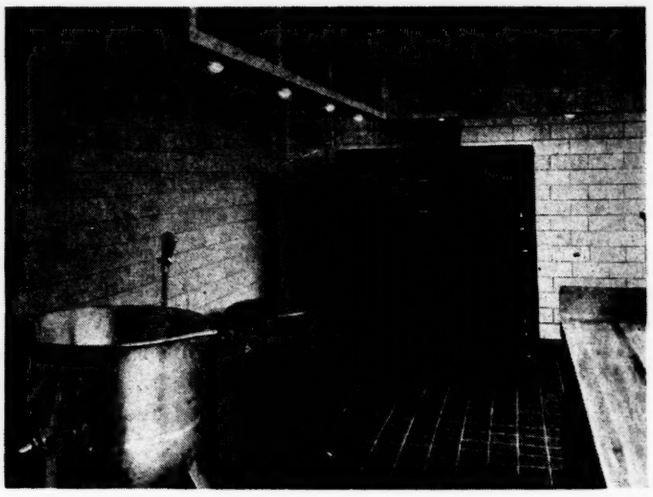
Another innovation that greets the eye is the glass brick wall on the exposed sides of the addition which afford maximum light to the working areas during daylight hours. Flush type fluorescent fixtures furnish even, shadowless illumination at other times. Designed by the District of Columbia Architects' Office, the latest and best equipment was installed to provide the most efficient flow of food handling through all the phases of preparation, cooking and serving.

In the kitchen proper, the gas cooking equipment consists of four sections of hotel type solid top ranges, three deep fat fryers, two broilers and two combination roasting and baking ovens. The fryers and ovens are thermostatically controlled. Another feature of this new layout is a separate bakery with a six-section



Pressure cookers, gas ovens, and urns under glass hood.

deck type gas bake oven with thermostatic control, a gas candy stove and a trunnion kettle. All gas cooking equipment is of the most modern design, and was purchased to carry an almost continuous cooking load as hospitals in general feed twenty-four hours a day. The other auxiliary equipment, including steam kettles and pressure cookers, are of the same high standard. Stainless steel storage bins have been installed with



Section of bakery showing oven, trunion kettle and candy stove under hood.

particular emphasis placed on their proper ventilation for safe storage of food. A tiled pipe chase, in which all the piping for the stock kettles, ranges, and ovens is concealed, is located behind the cooking equipment.

The layout, modern gas cooking equipment, the up to date accessory appliances, and the specially designed ventilating system make up a kitchen that incorporates the latest ideas in ventilation.

# Design, Performance and Selection of AXIAL FLOW FANS

HEATING AND VENTILATING'S Reference Section

**According to standard nomenclature adopted by the National Association of Fan Manufacturers, all existing types of fans are classified into four categories: Propeller fans, tubeaxial fans, vaneaxial fans, and centrifugal fans. The first three types, the operating principles of which are quite similar, will be discussed in this article. An article on the fourth type, the operating principle of which is quite different, is in preparation and will appear in the near future.**

**FRANK P. BLEIER**

**Director of Research, Ilg Electric Ventilating Co., Chicago, Ill.**

THE design of a fan unit of any type is a most interesting problem. The fan designer who compares the problems encountered in his work with those encountered in the design of other types of machinery will assure you that in most cases he will decide he would rather design a fan. The casual observer will in general not realize this fact; if he never had any contact with the particular field of ventilation, he will not realize that there is any such thing as mathematical fan design and calculation of optimum dimensions for a fan unit or as the pattern of the air flow through a fan unit and the theoretical predetermination of this pattern. Let us dwell on the casual observer for a moment and let us try to put ourselves in his place and to look at the problem of fan design in general as he would do. His point of view will be about as follows:

"Take a few paddles, call them blades, and fasten them somehow symmetrically around a hub. Put this fan wheel in some kind of a housing and test it. If it does not give you 'enough air', try to make certain changes on the unit: increase the size, the speed, the number of blades, the blade angle, the blade width, and the famous 'scooping' curvature. Keep on changing and retesting until you just about get what you want."

This viewpoint of the casual observer naturally is rather primitive. In certain respects it is even incorrect, as it overlooks certain limitations, such as the fact that the addition of blades or the increase of blade curvature does not always result in an increased air delivery. But you cannot blame him for that, if you stop to think that until a few decades ago, this was also the conception of the professional ventilating engineer and fan designer. And you must admit one thing: as primitive as this purely experimental hit and miss method may be, with a sufficient amount of persistence, time and money, it will in general be possible to obtain the desired air volume and pressure by the application of this method.

There are only three objections to this method:

(1) The resulting units will in general be larger and run at a speed higher than necessary.

(2) This method is too expensive, because it will in general require the building and testing of three to six units until the desired air volume and pressure is obtained.

(3) This method will practically always lead to units with air flow which is uneven and turbulent and with stalling effects in certain portions of the blades. As a result of all this, these units will be inefficient and noisy.

The method just described is one for *building* fan units. It is the one that has been used more or less exclusively for a long time. Engineering progress could be called the advancement from *building to*

*designing*. Today fan units have to be designed before they are built. The war with its requirements for high quality equipment has forced the fan manufacturers to this conclusion, and any manufacturer still refusing it will have a handicap in post-war competition.

Once the necessity of fan design on a theoretical basis has been recognized, the first question is: Is it at all possible to determine the dimensions for a fan unit so that it will meet a certain set of specifications, by pure calculation, this way completely eliminating the use of any experimental hit and miss method? The answer is: yes, this is possible, and even more than that, it is possible in more than one way; in other words, there are many designs possible that will meet a certain set of specifications with respect to air delivery. This naturally leads to the next question: If this problem to meet the specifications can be achieved by units of different designs, is it possible to find one optimum design? The answer is again yes, providing that a definition for the word "optimum" can be agreed upon.

The question "what is the optimum design?" is of rather complex nature and the answer to it will vary with the prospective application of the fan unit. In the great majority of cases it will include among other things the call for highest possible efficiency and lowest possible sound level—both over the widest possible range of operation. Other things may be, for instance, non-overloading brake horsepower characteristic; or flat pressure curve, which means large free delivery; or steep pressure curve which means little variation in air delivery throughout the operating range; or large pressure safety margin; or compactness; or some other supplementary requirement that may be desirable in a certain application. The combination of these often results in interference problems and in conflicting requirements whose relative weight of importance has to be considered before a decision is made.

## Types of Fans

Fans of the axial flow type are—as the term indicates—fans in which the direction of the air flow is essentially parallel to the axis of rotation. As per NAFM Standard Nomenclature, they are classified as propeller, tubeaxial, and vaneaxial fans. Various other terms have been used in industry, such as air screw fans, spiral fans, disc fans, etc., which of course make the terminology rather confusing; the trend, however, seems to indicate that the three NAFM standard terms will soon be used generally, which policy will also be followed in this article.

As mentioned before, the fundamental operating principle is about the same for these three categories; accordingly the design procedures for them are quite similar. As to both construction and performance, however, there are some differences. We may anticipate one statement right here: The sequence, propeller—tubeaxial—vaneaxial, also indicates the general trend of increasing weight, price, hub diameter, static pressure, aerodynamical load (AHP), and efficiency.

*The Propeller Fan*, as shown in Fig. 1 and 2, is the lightest and most commonly used unit. The fan wheel runs inside a narrow mounting ring which is sometimes shaped like an inlet bell and which is sometimes extended to a square mounting panel. The mounting ring carries the motor support with the motor, which usually is located on the inlet side, as in Fig. 1, but sometimes on the outlet side as in Fig. 2. The wheel has a small hub diameter, from 20 to 45% of the wheel diameter, and is designed to operate in the range near free delivery.

*The Tubeaxial Fan*, as shown in Fig. 3, is a glorified propeller fan. Its outside appearance is often that of a short cylinder, about ½ to 1 diameter long. This cylinder contains the fan wheel, the motor support and the motor, which usually is of the round body type and which can be located on either side of the fan wheel. The wheel has a medium size hub diameter, from 35 to 60% of the wheel diameter, and the unit is designed to operate in the range of moderate static pressures.

*The Single Stage Vaneaxial Fan*, as shown in Fig. 4 and 5, is a more elaborate unit. It has the outside appearance of a cylinder, about 1 to 1½ diameters long, which contains the same parts as the tubeaxial fan and in addition a set of guide vanes that are usually arranged around the motor. Motor and guide vanes can be located either on the inlet side (Fig. 4) or on the outlet side (Fig. 5). The wheel has a large hub diameter, from 50 to 80% of the wheel diameter, and the unit is designed to operate in the range of high static pressures.

*The Double Stage Vaneaxial Fan*, as shown in Fig 6, has the outside appearance of a long cylinder, about 1½ to 2 diameters long, which contains two fan

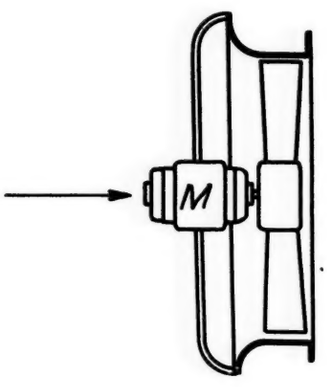



Fig. 1. Propeller fan with motor on inlet side.

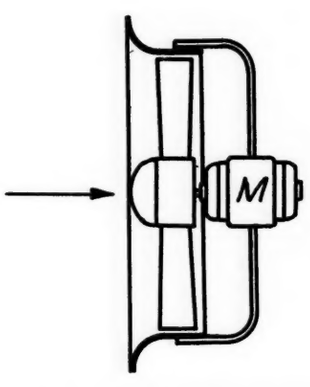



Fig. 2. Propeller fan with motor on outlet side.

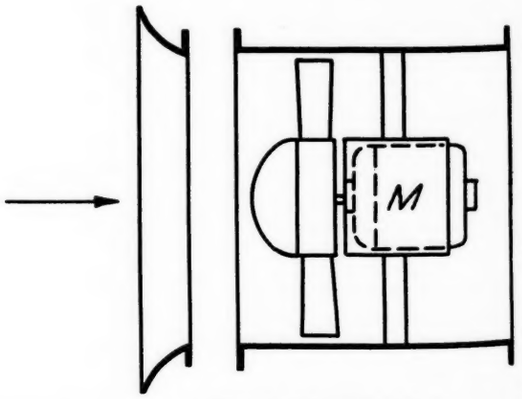



Fig. 3. Tubeaxial fan.

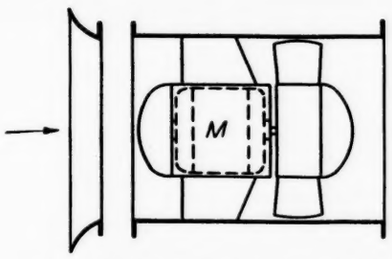



Fig. 4. Single stage vaneaxial fan with inlet vanes.

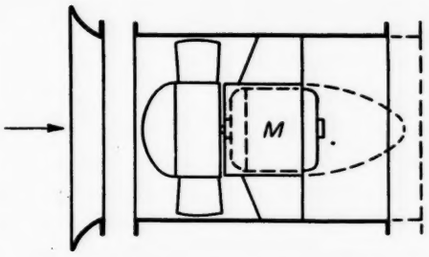



Fig. 5. Single stage vaneaxial fan with outlet vanes.

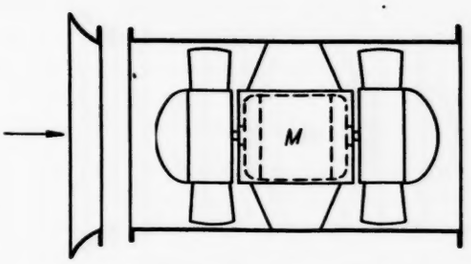



Fig. 6. Double stage vaneaxial fan.

wheels instead of one, usually driven by a double shaft extension motor. The guide vanes are usually arranged around the motor and therefore located between the two fan wheels. The wheels have large hub diameters, from 60 to 80% of the wheel diameter, and the unit is designed to operate in the range of very high static pressures, high enough to meet practically all conditions ever arising in ventilation.

*Multi-Stage Vaneaxial Fans,* with more than 2 stages, have been built, but they are not at present of interest as far as the field of ventilation is concerned.

The cylindrical shape of the tubeaxial and vaneaxial fans makes them suitable for straight line installation. In this case a round duct is connected to either end of the unit, and no intermediate transition pieces are necessary.. A unit installed at the inlet of a system, however, needs as an additional part an inlet bell, as indicated in Fig. 3 to 6. The inlet bell prevents the forming of a vena contracta (see Fig. 7) on the casing edge. The inlet hood, which is either part of the wheel or attached to the wheel, serves a similar purpose on the hub edge.

Fig. 8 and 9 show two views of a single stage vaneaxial fan with outlet vanes. Fig. 10 illustrates the function of an inlet bell. Table 1 shows the highlights of the above general description of the different types. Each of them can be driven either by a directly connected motor or by a belt-drive mechanism. In the great majority of cases, there will be no doubt that direct connection is by far the superior arrangement, except in the case of giant sizes where the fan wheel must run at low speed.

## Fundamental Principles of Operation

Fans of the axial flow type operate on a principle which is sometimes called "propeller action"; another descriptive term is "airfoil principle". Every fan of this type operates on the airfoil principle even if not real airfoil sections are used as cross-sections of the blades, but only simple shapes, sometimes as primitive as flat plates instead of airfoils.

A glance at the schematic sketch Fig. 11 will refresh our memory as to what is meant by the expression "airfoil principle". It shows a flat plate of, for instance, rectangular shape which is placed in an air stream at angle $\alpha$ relative to the direction of the air stream. The edge which hits the air first is called the leading edge; the other one, the trailing edge. There are apparently two effects to be investigated in this set-up: first the effect on the air stream, and second the effect on the plate. The main effect on the air stream is that it will be diverted downwards. The main effect on the plate is that it will be lifted upwards.

The air stream exerts a little pressure—positive or negative—on each little portion of the plate surface, and the vectorial resultant of all these pressures is a force exerted on the plate as a whole, as shown in Fig. 11. This force whose magnitude and direction naturally depend on the angle of attack $\alpha$, can be resolved into two components: a vertical force, called lift $L$, and a horizontal force, called drag $D$. The interaction between air stream and plate will take place with greater efficiency, or, more technically speaking, with a higher lift-drag ratio L/D, if a profiled plate is used instead of the primitive flat plate. The shape of such a profile is shown in Fig. 12 and is called an airfoil.

By looking at Fig. 11 and 12, one can well visualize both effects, the downward diversion of the air stream and the lifting force exerted on the plate. One will also get the impression that these effects are produced by the positive pressures on the lower side of the airfoil. It is well worth mentioning that this conception is wrong. In typical airfoils, about 70% of the effect is produced by the negative pressures on the upper side and only about 30% by the positive pressures on the lower side. The exact conditions naturally vary with the angle of attack and with the shape of the airfoil.

The most important application of the airfoil shape is in the airplane wing, or, more specifically, in its cross-section. It is the lifting effect on the profiled wing that is utilized in this application. The next important application of the airfoil shape is in the cross-section of blades on machines based on the principle of propeller action such as fans of the axial flow type. Other examples of this group are airplane propellers, ship propellers, compressors of the axial flow type, etc. It is the diversion of the air stream that is utilized in this application.

## Hub Diameter

As mentioned before, the design procedures for propeller, tubeaxial, and vaneaxial fans are quite similar. The main problem in all cases is that the velocity of the blades is low near the center and becomes greater towards the tip. On the other hand, the governing factor in the design procedure is the requirement of constant air flow all over the working face of the fan wheel. Some means, therefore, will have to be provided to make up for the variation of the blade velocity along the radius.

The requirement of constant air flow all over the working face of the fan wheel obviously can be met only if the air velocities have no component in radial direction; in other words, the air particles should flow

along various cylindrical surfaces concentric with the hub and around blade sections that are obtained by intersection of these cylinders with the blades. The air flow produced by these different blade sections at varying radii should be constant. Expressed in mathematical symbols, the requirement means that the stage pressure

$$P = \frac{\delta}{2} n\ z\ C_l\ l\ V$$

must be constant for all sections where

$\delta$ = air density
$n$ = rps
$z$ = number of blades
$C_l$ = lift coefficient
$l$ = blade width
$V$ = average relative air velocity

Considering the air flow for the point of design, the relative velocity $V$ is smallest at the hub, and the pressure produced $P$ will therefore also be smallest at the hub (which must be avoided), unless this decrease of $V$ is compensated by an increase of the other factors favorably affecting the pressure produced. However, these other factors (they are—as the formula shows —the blade width $l$ and the lift coefficient $C_l$) can be increased only up to a certain limit. Therefore, the hub diameter to be selected can be decreased only down to a certain limit, and if a value below this limit is selected, partial stalling will occur.

Many fans, installed in the field, operate under the condition of partial stalling due to too small a hub diameter. This means, that a portion of the blade adjacent to the hub does not produce the pressure against which the unit as a whole is working in this installation, or more technically, in this system characteristic. This of course, results in a reduced air flow and often even in a back flow in the annulus adjacent to the fan hub, which in turn decreases the efficiency of the unit, since for best efficiencies constant air flow is essential.

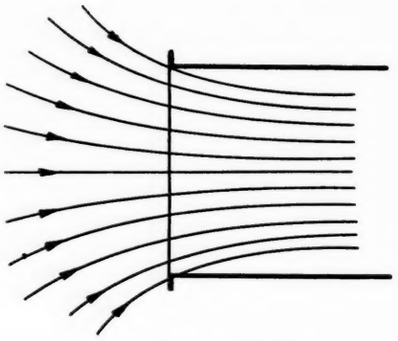


Fig. 7. Vena contracta.

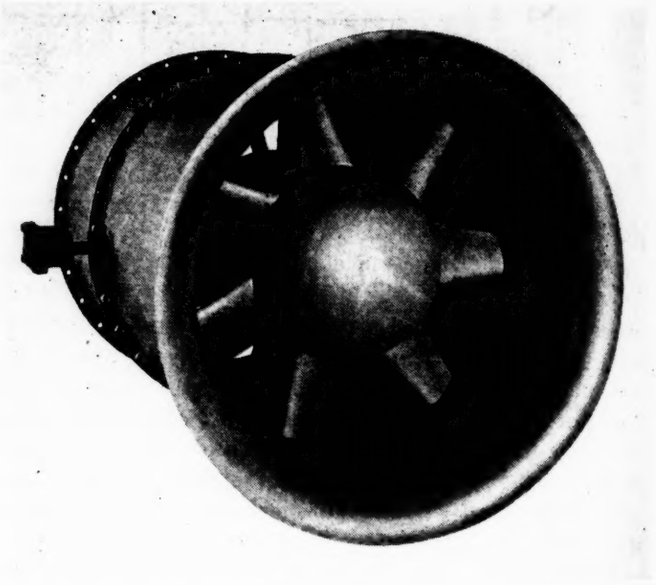


Fig. 8. Vaneaxial fan with outlet vanes. View from inlet side.

The minimum necessary hub diameter is at the same time the optimum hub diameter. The use of a hub diameter smaller than necessary is quite critical. The use of a hub diameter larger than necessary is by far not so critical; it merely results in a decrease of the annular area and consequently in a small increase of the air velocities and therefore of the losses, or in other words in a slight drop in the efficiency.

The following conclusions can be drawn, by application of the above: As just explained, the hub diameter has to increase with the pressure to be produced. This checks with the statements made in Table 1, whereby the vaneaxial fan, which should be used for the highest pressures, has the largest hub diameter; whereas the propeller fan, which should be used for the lowest pressures, has the smallest hub diameter. It should be mentioned in this connection that fans hardly ever operate at completely free delivery, and that even the propeller fan usually operates against some small pressure. For good efficiency it will therefore be advisable that even the propeller fan have some hub diameter, although it will in general be below that of other types.

### Shape and Function of the Blades

In addition to the requirement of constant air flow, the following other factors have to be considered in the design of the blade:

**Table 1 — Features of Fans of the Axial Flow Type**

| Type | Casing | Motor Support | Guide Vanes | Hub Diameter | Static Pressure |
|---|---|---|---|---|---|
| Propeller Fan | Mounting Ring or Mounting Panel | Inlet Side of Panel Preferred | None | Small | Low |
| Tubeaxial Fan | Short Cylindrical Housing | Inside Housing, Outlet Side Preferred | None | Medium | Moderate |
| Single Stage Vaneaxial Fan | Cylindrical Housing | Inside Housing, Either Side Used | Around Motor Support | Large | High |
| Double Stage Vaneaxial Fan | Long Cylindrical Housing | Inside Housing, Between the 2 Stages | Around Motor Support | Large | Very High |

(1) Tangential conditions of the relative air velocity at the leading and trailing edge of the blade.
(2) Proper selection of the lift coefficient $C_1$.
(3) Selection of a suitable airfoil and utilization of the proper working range of this airfoil.
(4) Proper number and spacing of the blades.

These factors will sometimes result in conflicting requirements so that it will not be possible to satisfy all of them completely. In such cases, a compromise solution will have to be found in such a way that the overall condition is as nearly an optimum as possible.

### Blade Angles

The blade angle in each section is made the sum of the average relative air angle and of the angle of attack.

The velocity of the rotating blade increases from small values at the hub to large values at the tip; by a more detailed study of the conditions (developing of velocity diagrams), it could be shown that, due to this variation and in view of the requirement of constant air flow, the air angles must decrease from large values at the hub down to small values at the tip. The angles of attack usually have—for the point of design—no or comparatively little variation from hub to tip. The blade angles, being the sum of the air angles and the angles of attack, therefore also decrease from hub to tip, which results in a twist of the blade that is typical for fans of the axial flow type.

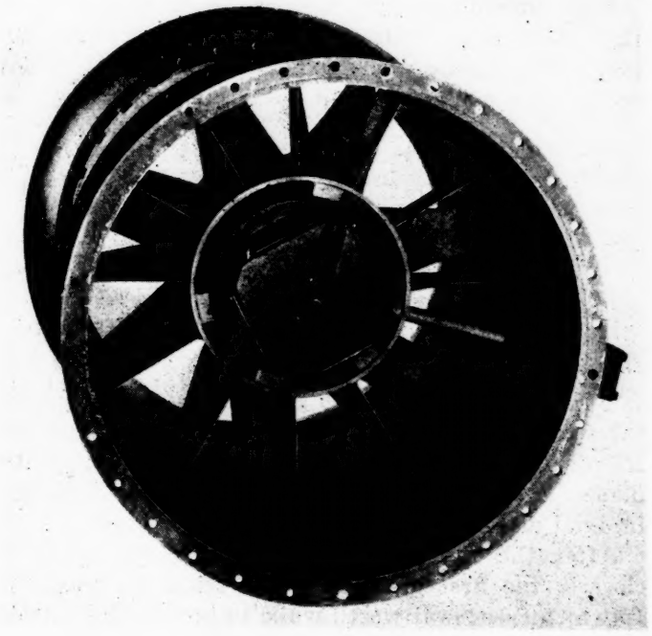


Fig. 9. Vaneaxial fan with outlet vanes. View from outlet side.

### Blade Widths

The width of the blades is not measured straight across the blade, but along a curve, or to be exact along the intersection of a cylindrical surface with the blade. The formula given for the stage pressure shows that the blade width is an important dimension, as it has a strong effect on the pressure produced. In some designs the width is constant all the way from the hub to the tip of the blade, but very often it varies. As far as the point of design only is concerned, the fan designer has a certain amount of freedom in selecting the blade width, as variations in the blade width for a certain section can be compensated by corresponding variations in the lift coefficient of the profile used in this section. This freedom is used to control certain performance features, not just concerning the point of design. The first and most natural idea would be to make the blade becoming narrower towards the tip, because of the greater blade velocity at the tip, as discussed in the previous section. In fact, many fan wheels are built that way. Sometimes, however, conditions are such that wide-tip blades have certain advantages. The decision on that depends on certain additional performance requirements that will be discussed later. We may anticipate that—under otherwise equal conditions—usually wide blades result in higher pressure safety margin and lower sound level, while narrow blades result in larger free delivery, lower no-delivery brake horsepower, and less sensitivity of the sound level to inlet turbulence.

### Number of Blades

The stage pressure in each section is proportional to the product, number of blades times blade width. This means that a certain wheel can be modified by, for instance, doubling the number of blades and reducing their width to one-half, without any appreciable change in the fundamental design and in the performance of the unit, at least as far as volume and pressure at the point of design are concerned. The selection of the number of blades is largely a matter of experience, and no definite rule can be set for the optimum number of blades, except that a smaller number usually is desirable for optimum performance, especially for low pressures, as long as this is not overdone. If the number of blades becomes too small and the blade width therefore too great, difficulties have to be expected, not only regarding certain performance features, but also regarding the mechanical construction, as an overly

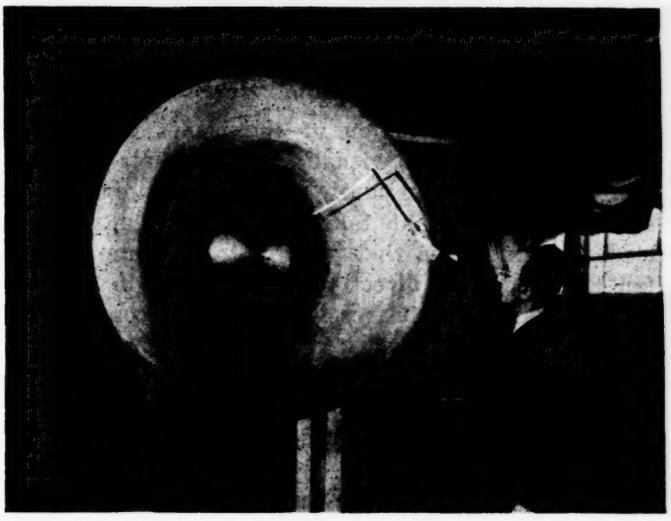


Fig. 10. Inlet bell preventing the forming of a vena contracta at inlet of vaneaxial fan. Note shadow of string indicating that string does not touch surface of bell.

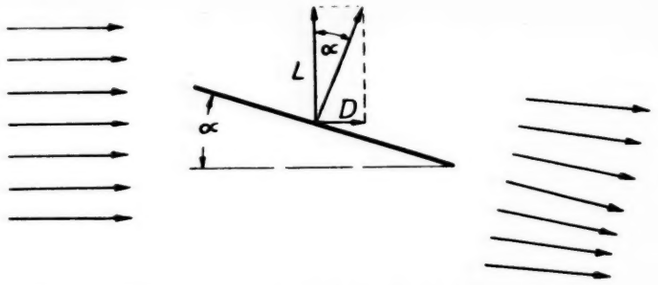



Fig. 11. Flat plate placed at an angle in an airstream.

large axial width of the fan wheel would make it bulky and heavy.

### Cross Section of the Blades

Best results are obtained by the use of airfoil shapes as cross-sections of the blades. There are many differences in airfoils with respect to their shape (maximum thickness, thickness distribution, maximum camber, camber distribution, shape of leading and trailing edge) and correspondingly with respect to their performance. The problem will be to pick out certain airfoil shapes that are best suited for certain types of fan units.

Airfoil blades are usually made as aluminum castings, incorporating both features, the twist in the blade angle and the airfoil shape in the cross sections (see Fig. 13). Another construction used by a few manufacturers is that of hollow steel airfoil blades. Special care regarding close tolerances has to be taken in the manufacture of fan wheels having airfoil blades. Inaccuracy due to warpage, etc., would spoil the good performance that can be obtained with airfoil blades.

In many applications, especially for low pressure units, fabricated single sheet steel blades are used instead of airfoil blades (see Fig. 14). The cross-sections of this type of blade are curves substituting airfoils and derived from some airfoil mean lines. The correct shape of these curves naturally is of importance for the performance. For accuracy and economy of production, such blades have to be pressformed in a die that takes care of the springback of the material used for the blades. Oversimplified blades, as are sometimes found in connection with low priced propeller fans, naturally result in inefficient and noisy operation.

### Function and Location of Guide Vanes

Considering the action of the blades on the air stream, it is easy to visualize that the air particles are not only moved in purely axial direction, but at the same time somewhat taken along by the rotating blades. This means that an air stream entering the fan wheel in axial direction, will leave it in a spiral motion, which can be resolved into two components, an axial component and a rotational component. The axial component carries the useful portion of the kinetic energy. The rotational component represents an energy loss, unless it is by some means converted into useful energy.

The above consideration leads us to the main difference between the vaneaxial fan and the tubeaxial fan. In the vaneaxial fan, guide vanes are provided whose function it is to eliminate the energy loss that would otherwise be caused by the rotational component, or at least the major portion of it. In tubeaxial and propeller fans, no guide vanes are provided, and the kinetic energy contained in the rotational component is lost (or at least a major portion of it). Under otherwise equal conditions, the vaneaxial fan will therefore have a greater energy output (air horsepower) at the same energy input (brake horsepower) and, as a result of this, a higher efficiency. For specified output requirements, on the other hand, higher efficiency naturally means saving in brake horsepower.

There are two ways in which the guide vanes can be provided to perform their function of eliminating (or reducing) the rotational energy loss: They can be located either on the inlet side or on the outlet side of the fan wheel.

The function of the outlet vanes is easier to understand. It is illustrated in Fig. 15. The air leaving the blades in a spiral motion in the direction of the fan rotation, enters a set of stationary vanes that guide the air flow back into the axial direction.

The function of the inlet vanes is illustrated in Fig. 16. The air is first drawn through the vane section which guides the air flow into a spiral motion whose rotational component is directed *opposite* to the

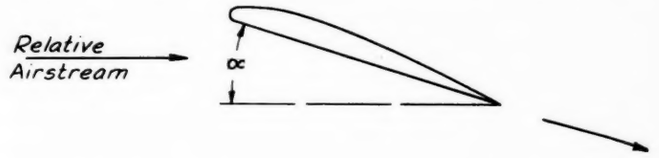



Fig. 12. Airfoil placed at an angle in airstream.

fan rotation and is just big enough to make up for the spiral motion in the direction of the fan rotation that is afterwards imposed upon this air flow by the blades. As a result of this, the air leaves the blades in axial direction.

After the function of the guide vanes has been cleared, the first question to be asked naturally is: In which cases is it worth while to provide such guide vanes? Or in other words, in which cases should the more elaborate and more expensive vaneaxial fan be used instead of the tubeaxial fan or instead of the propeller fan? The answer is: The vaneaxial fan should be used in all cases where high efficiency or high pressure is required. The reason why the vaneaxial fan is indicated in cases of high efficiency requirements was given earlier in this section: it has under otherwise equal conditions the greater air horsepower at the same brake horsepower. The reason why the vaneaxial fan is indicated in cases of high pressure requirements follows: The theory, verified by test, shows that the rotational component of the spiral motion increases with the pressure produced. This means that in cases where high pressure is to be produced, the rotational component and thereby the energy losses will be considerable, and the use of guide vanes will be advisable.

The next question to be asked will be: What determines the best location of the guide vanes? This question is somewhat complex and can be answered only after a study of the requirements in the par-

ticular case. The following analysis will serve as a guide in this study. In the case of inlet vanes, the spiral motion on the inlet side increases the velocity of the air relative to the blades. This results in a condition similar to that of an increased fan speed. Inlet vanes will therefore, under otherwise equal conditions, result in larger air volume and higher static pressure, but also in more noise at the design point.

For specified output requirements, on the other hand, this may sometimes permit a reduction of the necessary fan speed (which may or may not be desirable in a certain case), whereby not only the sound level may be dropped back to the level of outlet vanes, but whereby at the same time the sensitivity of the sound level against inlet turbulence may be decreased. It should be emphasized, however, that inlet vanes are not necessarily the generally superior arrangement. Each of the two arrangements has its place, and while the use of vanes will always improve the performance of a unit, the decision on their location will depend on the requirements of the particular case.

## Shape of the Guide Vanes

The shape of the guide vanes is schematically shown in Fig. 15 and 16. As indicated there, the vane angles are determined from the requirement of tangential conditions at the leading and trailing edge of the vane. The width and spacing of the vanes follow considerations similar to those generally used in the design of turning vanes in duct elbows. The considerations are however not quite the same, due to the fact that the air flow in elbows usually does not change its velocity, whereas inlet vanes operate in accelerated air flow and outlet vanes in decelerated air flow; furthermore, the spacing should be selected in such a way that the number of vanes has no common divisor with the number of blades, so that simultaneous crossing of blades and vanes (which would tend to make the air flow uneven and noisy) is avoided.

Since the guide vanes are stationary, the relative air velocities and therefore the losses are here much smaller than in the blades. From this it might be surmised that the shape of the guide vanes is not quite so critical as that of the blades. This is actually true

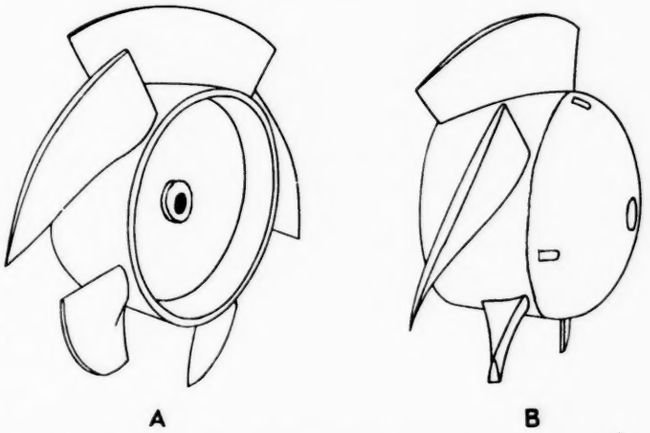



Fig. 13. Fan wheel with cast aluminum airfoil blades. A—without hood. B—with hood

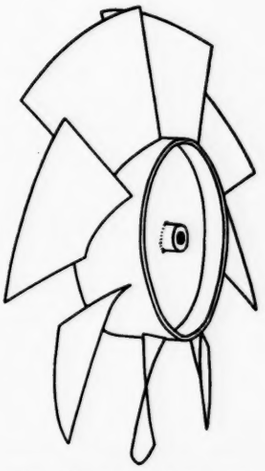


Fig. 14. Fan wheel with die formed single sheet steel blades.

for outlet vanes. The shape of inlet vanes, however, is still critical, not because of the comparatively small losses occurring in them, but because of the indirect effect upon the subsequent blades. For if the spiral air motion entering the blades is not in accordance with the calculation, the blades will not operate under the precalculated conditions and naturally will not perform as expected. This is probably one of the reasons why many manufacturers prefer outlet vanes.

The cross-section of the guide vanes can—like that of the blades—be either an airfoil shape or a single line of proper curvature. Airfoil vanes are made as aluminum castings (or sometimes of hollow steel construction) while single sheet steel vanes are fabricated in a press forming die. The single sheet steel construction is more commonly used and will usually result in a satisfactory performance, so that the extra expense of the airfoil construction is not always justified. For certain performance features (such as a wide efficiency curve), airfoil vanes will be useful, especially in the case of the more critical inlet vanes. The appearance of single sheet steel vanes is shown in Fig. 14.

## Double Stage Vaneaxial Fans

A double stage vaneaxial fan with guide vanes between the two fan wheels is shown in Fig 6 and a general description of the construction has been given. The function of this unit is explained as follows: Two vaneaxial fans, having the same wheel diameter, the same hub diameter and delivering the same air volume could be connected in series. They would then deliver the same air volume, but against a static pressure equal to the sum of their individual static pressures. If the first unit had outlet vanes and the second one inlet vanes, and if they furthermore had the same running speed, the same rotation and the same number of vanes, the two units could be joined into one double stage vaneaxial fan unit, as shown in Fig. 6.

The vanes in this unit will be a combination of inlet and outlet vanes and will have the function to reverse the direction of the rotational component of the spiral air motion.

## Counter Rotating Fan Wheels

It can now be seen that in the unit just described, it might be possible to eliminate the guide vanes and to use the spiral air motion leaving the first wheel as inlet motion for the second wheel, which in this case naturally would have to rotate in the opposite direction. This is actually possible. The resulting unit, however, is not very practical, mostly because of difficulties in the mechanical construction.

## Performance and Application

The standard methods according to which fans are to be tested are described in Bulletins 103 and 104 prepared jointly by the NAFM and the ASHVE. Various standard test set-ups are shown for which the basic principle is: Set the fan unit up in a manner similar to that in which it presumably will operate when installed in the field. Establish different operating conditions (system characteristics) by throttling the test system. For each condition, measure everything that is needed in order to determine by subsequent calculation the fan output (cubic feet per minute, pressure, sound level) and the fan input (motor brake horsepower), so that the characteristic curves can be drawn.

One particular fan, if tested in different set-ups will show slightly different performances, just as the unit will perform somewhat differently, depending upon the way it is installed in the field. It is, therefore, essential to indicate on performance curve sheets which set-up has been used in testing the unit.

## Shape of Performance Curves

Fig. 17 shows the general shape of the performance curves for a fan of the axial flow type. Four curves are plotted against volume output, showing the variation of the static pressure, brake horsepower, mechanical efficiency and sound level for varying volume. The following characteristics are to be noted in the shape of such performance curves.

*The pressure curve,* starting at the free delivery point and going through the point of design, rises to a maximum value somewhere between 120 and 160% of the design pressure where the operating range ends and the angles of attack become so big that separation of the air flow takes place and stalling occurs. The stalling range, i.e. the range to the left of this stalling point, consists of a more or less pronounced stalling dip and a succeeding stalling rise. Precaution must be taken in the selection of fans, so that the unit when installed in the field does not operate in any part of the stalling range.

*The brake horsepower curve* is somewhat similar in shape to the pressure curve, but has less variation.

*The efficiency curve* has its maximum at the point of design.

*The sound level curve* has its minimum at the point of design. It shows little variation within the operating range, but a sudden increase at the stalling point, where the air flow becomes turbulent. After this sudden increase, which in the range of higher tip speeds is often as much as 15 db, the unit stays noisy throughout the stalling range and shows little variation within this range.

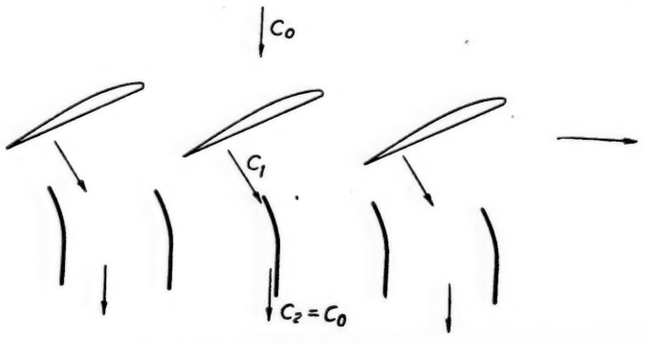



Fig. 15. Function of outlet vanes.

## Comparison of the Different Types

Fig. 18 shows a comparison of the volume-pressure curves only, for four fans of the axial flow type, having the same wheel diameters and the same running speeds. The full line shows the performance of a propeller fan, the long-dashed line that of a tubeaxial fan, the short-dashed line that of a single stage vaneaxial fan, and the dotted line that of a double stage vaneaxial fan. This figure gives a typical picture of the general shape of such curves and of their relationship to each other. There are similarities and dissimilarities between the different curves.

Similarity is found in the fact that all four curves have the same basic shape. They could even—if drawn individually and with modified pressure scales—have almost the same appearance. In the operating range where the pressures are produced by airfoil action and where, as a result of proper design, the air flow is free of turbulence, the unit is efficient and quiet. This condition, however, ends as soon as the stalling pressure at the peak of the pressure curve is reached. From here on the air flow is turbulent and the unit is inefficient and noisy. In the stalling range, the pressures

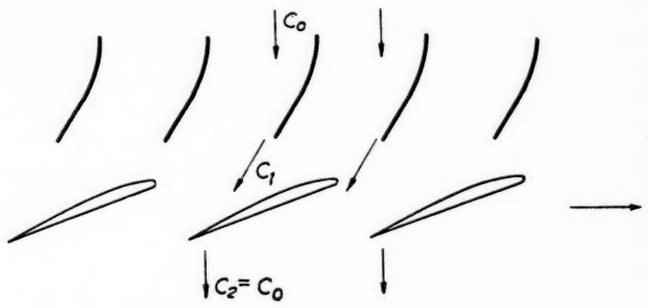



Fig. 16. Function of inlet vanes.

are produced by a combination of stalling airfoil action and centrifugal force; the latter gains more and more weight, as the no-delivery point is approached. Since all this applies to all the four fans in Fig. 18, this similarity in the shape of the curves was to be expected. This point cannot be emphasized too much, as the difference between these four types of fan is still frequently over-estimated.

Dissimilarity is found in the fact that the four fans operate against quite different static pressures—or more precisely against different system characteristics, as indicated by the parabolic lines in Fig. 18. The static pressures increase in the sequence, propeller fan —tubeaxial fan—single stage vaneaxial fan—double stage vaneaxial fan, as mentioned before. The air volumes at free delivery tend to decrease in the same sequence, but by far not so much as the static pressures increase. Consequently the air horsepowers (being proportional to the product, air volume times total pressure) also increase in this sequence.

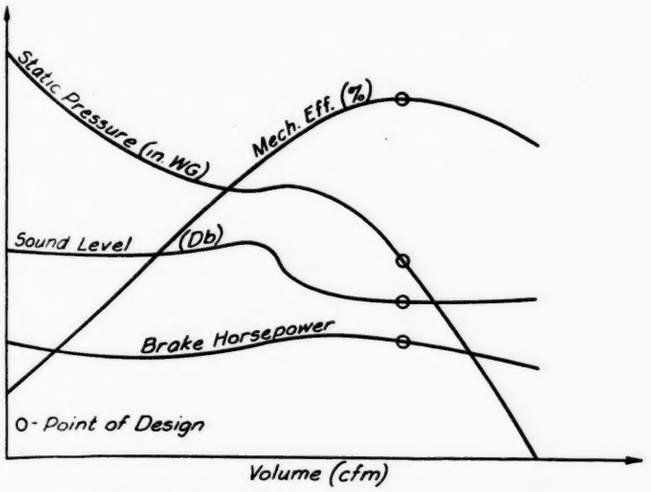



Fig. 17. General shape of axial flow fan performance curves.

Designs could be worked out that would give a different picture. For instance, a vaneaxial fan could be designed for a static pressure lower than that of a tubeaxial fan of the same size and speed. Such a relationship, however, would not be typical. The removal of the guide vanes will generally result in a reduction of the static pressure in the case of outlet vanes and in a reduction of volume, static pressure and sound level in the case of inlet vanes. The resulting reduction in air horsepower will in the average be somewhere between 10 and 40%, while the maximum efficiency will drop by 10 to 30%.

## Pressure Safety Margin

The pressure safety margin of a unit shall be defined as the difference between its maximum operating pressure and the rated pressure. It usually is from 20 to 60% of the rated pressure. Its purpose is to allow for possible errors that may have been made in the determination of the system resistance, which to a large extent consists of estimates rather than strict calculations; and to allow for possible fluctuations of the system.

Precaution must be taken in the selection of fans so that the pressure safety margin is not too small, as such a condition might result in an installation where the unit operates in the stalling range. On the other hand, the pressure safety margin should not be made larger than really necessary as this would increase the motor horsepower required.

The pressure safety margin is easy to control. Its amount depends entirely upon the lift coefficient $C_1$ (point on the airfoil's performance curve) that is used in the calculation for the rated point of design. The further away from the maximum lift coefficient (stalling point of this particular airfoil) this lift coefficient $C_1$ is selected, the greated will be the pressure safety margin of the unit.

## Control of Overloading

In most fans of the axial flow type, the brake horsepower at and near the no-delivery point rises far above that in the operating range, thereby overloading the motor. There are installations, however, where the fluctuations of the system become so great that despite the pressure safety margin, the operating point is temporarily switched over into the stalling range, sometimes even to the no-delivery point. This may happen, for instance, if wind pressure works against the outlet of a system, or if the intake openings for the make-up air of an exhaust system are accidentally closed, or if the cooling coils of a refrigerating system freeze up, etc.

In such cases, it is an advantage if the design of the unit is such that the no-delivery brake horsepower is kept below the maximum brake horsepower in the operating range. This can be accomplished by certain design features that are derived proceeding from the fact that the no-delivery brake horsepower is produced by two effects: air turbulence and centrifugal action of the blades.

Anything that would reduce these two effects will also reduce the no-delivery brake horsepower. By careful control of the combination of lift coefficient and width and thickness of blades selected in the design calculation, the desired effect usually can be obtained without any harm to the performance in the operating range. Other quantities, such as hub diameter, number of blades and tip clearance, also influence the no-delivery brake horsepower, but their modification often endangers the operating performance.

The problem of controlling the no-delivery brake horsepower obviously is the hardest in cases of small aerodynamical load, such as propeller fans, and relatively easier in cases of heavy aerodynamical load, such as vaneaxial fans, especially those with inlet vanes, where the motor horsepower is already comparatively large for the size and speed of the unit. In any case, however, the problem is somewhat complicated by the rather limited freedom in modifying design features for this purpose. Naturally only such modifications may be made as do not at the same time have any adverse effect on the performance of the unit in the operating range, which after all is the most used and therefore most important range of the unit.

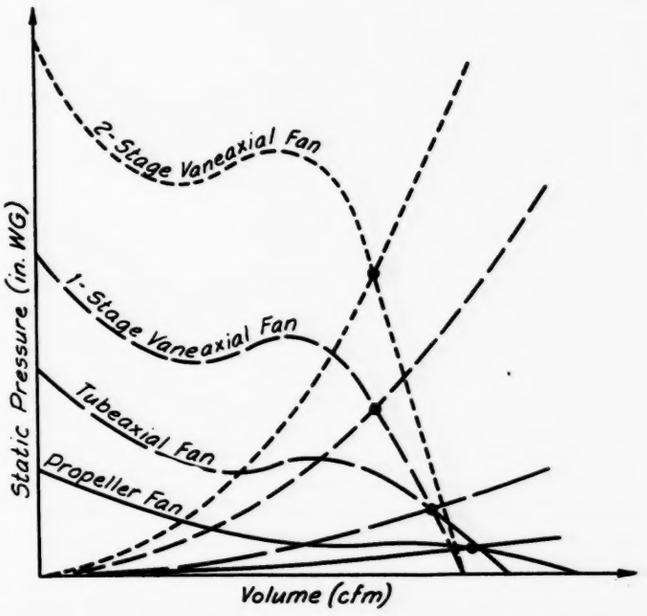



Fig. 18. Performance of different types of fans. Parabolic lines indicate system characteristics against which different fans operate.

## Sound Level

There are four sources of noise in a fan unit:

(1) Aerodynamical noise which is the result of turbulences in the air stream.

(2) Vibration noise due to unbalance of rotating members or to resonance of parts.

(3) Mechanical noise due to loose parts or to friction in bearings, etc.

(4) Electrical noise produced inside the motor.

The items (2), (3), and (4) can be reduced to a minimum by a sufficient amount of precaution. Item (1) is the main problem. The condition of minimum turbulence and therefore of minimum aerodynamical noise is obtained if the unit is designed correctly as described. Of greatest importance is the pattern of the air flow around the blades, because that is where the greatest relative velocities occur. The tangential conditions here are of paramount importance, as it is the blade edges rather than the blade surfaces that are apt to set up turbulences.

To avoid turbulences the unit should furthermore be streamlined in all parts and surfaces that have any contact with the air stream. The mechanical construction should be worked out in such a way that no bolts, bolt heads, nuts, etc., are projecting into the air stream. Support arms, conduit pipes, grease pipes and other sometimes unavoidable obstructions should be properly shaped to produce the least amount of turbulence.

A frequent source of noise is turbulence in the inlet air stream. Means should be provided so that the air stream is as smooth as possible when meeting the leading edge of the blades. Inlet obstructions are critical and should be streamlined. The inlet bell, doing a preparatory job, also serves this purpose; it prevents the forming of a vena contracta and lets the tip portions of the blades operate in undisturbed air flow. Theoretically, a logarithmically curved contour is required; practically an elliptic approximation will do in most cases.

Sometimes inlet turbulence is caused by the manner in which the unit operates in the field, either due to improper installation, which could have been avoided (for instance a duct elbow may be placed too close to the inlet of the unit), or due to some unavoidable peculiarity of the job. In such a case it may be an advantage if a unit can be used that is less sensitive against inlet turbulence, due to certain design features mentioned earlier in this article, even if this advantage of decreased sensitivity may be obtained at the expense of some other desirable feature.

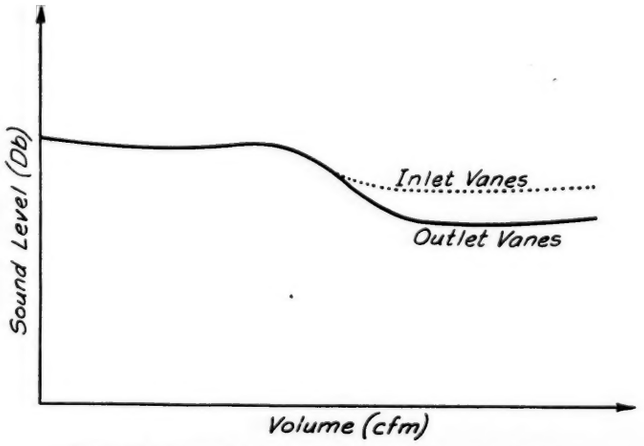



Fig. 19. Sound level curves of vaneaxial fans.

In the condition of minimum turbulence, most of the noise energy is contained in a musical note of the frequency, revolutions per second, times number of blades. In the case of a double stage vaneaxial fan with counter rotating fan wheels, the frequency is equal to the sum of the two speeds times the sum of the two numbers of blades. In the case of a double stage vaneaxial fan with guide vanes between the two fan wheels, two musical notes are produced.

Fig. 19 shows a comparison of the sound level curves for two vaneaxial fans of the same size and speed, one having outlet vanes (full line), the other one inlet vanes (dotted line). The curve for outlet vanes has that typical shape which has been shown in Fig. 17. The stability within the operating range and the pronounced difference between the operating and the stalling level usually indicate that the air flow in the operating range is smooth. If it were turbulent, the curve would keep its high stalling level almost constant not only in the stalling range, but over the complete range. The curve for inlet vanes has the same basic shape, but it shows a higher sound level in the operating range and therefore less difference between the ranges. This is due to the increase of the relative air velocities caused by the inlet vanes which naturally has the strongest effect in the operating range (large delivery) and practically no effect in the stalling range.

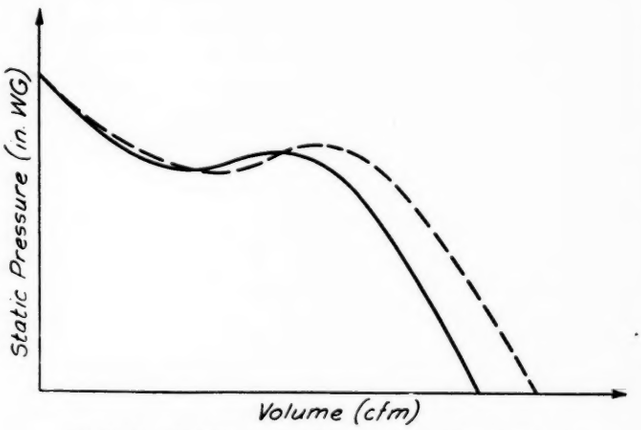



Fig. 20. Effect of a change of blade angle on pressure-volume curve.

## Aerodynamical Load

A proper aerodynamical load (air horsepower) is one of the important prerequisites for the design of a good fan unit. The proper load depends on the following three factors:

(1) *The type of fan.* Air horsepower increases in the sequence, propeller fan — tubeaxial fan—vaneaxial fan with outlet vanes—vaneaxial fan with inlet vanes—double stage vaneaxial fan.

(2) *The size of the fan.* Air horsepower increases with the fifth power of the size.

(3) *The speed of the fan.* Air horsepower increases with the third power of the speed.

Deviations from optimum conditions may sometimes seem indicated, due to practical considerations such as space requirements, etc. Such deviations are permissible within limits. Aerodynamical overload is more critical than underload. An aerodynamically underloaded unit has the disadvantages that it is often not as compact and not as quiet as it could be and that it is more likely to overload the motor at the no-delivery point. An aerodynamically overloaded unit, on the other hand, will have a poor efficiency; the higher the aerodynamical overload is, the lower will be the efficiency, until finally a point of performance breakdown will be reached where the specified air volume and static pressure will no longer be produced.

### Variation of Blade Angles and Vane Angles

Fig. 20 shows the effect of a change of the blade angle upon the pressure-volume curve. As can be expected, an increase of the blade angle results in an increase of the air volume; the static pressure and the slope of the curve in the operating range are also somewhat affected. The static pressure is increased; the slope of the curve is decreased. But these variations are by far not as great as that of the air volume. This effect can be utilized advantageously for modifications of original designs, as long as the variation in volume is not greater than plus or minus 25%. Greater variations are in general not advisable if good efficiencies are desired. The amount of variation naturally depends on the specific design; a 10% variation of the volume will usually require an angle variation of about 1.2 to 2.5°. Some companies manufacture fan wheels with adjustable blade angles in order to increase the flexibility of the unit. This naturally necessitates the use of a motor large enough to carry the load corresponding to the largest adjustable blade angle.

Another means of variation which is sometimes used on vaneaxial fans is that by vane angle adjustment. It can be applied to both outlet vanes and inlet vanes. The effect upon performance is stronger, but also more critical in the case of inlet vanes. Precaution must be taken so that the variation is kept within the permissible limit, since excessive variation of the vane angles naturally would result in a unit operating in the stalling range.

Either one of the two methods has certain advantages over the other one. The efficiency drop due to the variation is often smaller in the case of blade angle adjustment. The mechanical construction on the other hand is simpler in the case of vane angle adjustment, since the vanes are stationary.

### Tip Clearance

As explained, there are positive pressures on the pressure side of the blades and negative pressures on the suction side, which result in a pressure difference between the two sides. The uneven pressure distribution along the blade profile results in local pressure differences the maxima of which are much greater than the static pressures produced by the fan and that trend to cause back leakage across the tip clearance. This is critical, not because of the losses due to the back flow

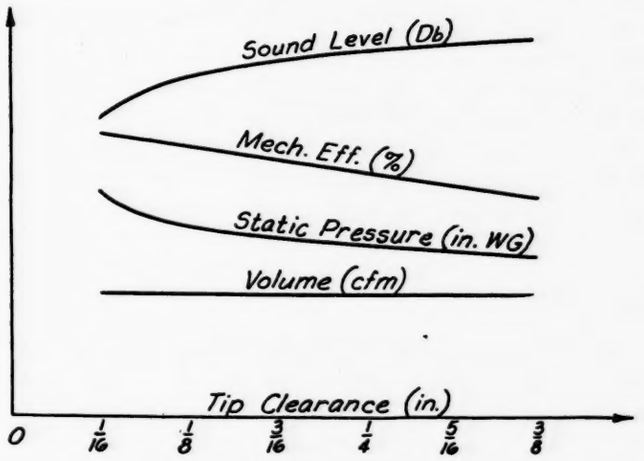



**Fig. 21. Influence of tip clearance on performance of a 29 in. vaneaxial fan.**

itself (the air volumes involved are comparatively small), but because of the indirect effect upon the blade tips. It would cause them to operate in turbulent air flow. Since the blade tips are the portion where the highest relative velocities occur, they are the most critical portion of the blade, as far as efficiency and sound level are concerned. This effect may therefore, if not kept within limits, become quite harmful to the performance.

The magnitude of the effect increases with the static pressure produced by the fan (which is about proportional to the local pressure differences), and with the amount of the tip clearance. This means that at high pressures (vaneaxial fan) the tip clearances have to be kept smaller than at low pressures (propeller fan). This of course requires accurate workmanship and in many cases machining of the casing inside and wheel outside, in order to prevent any possible scraping of the fan wheel on the casing.

Fig. 21 shows the influence of the tip clearance on the performance of a vaneaxial fan of medium size and static pressure. It is seen that for increasing tip clearance the air volume is not affected, the static pressure and the efficiency drop, and the sound level increases. While the basic shape of these curves is the same for all fans of the axial flow type, the amounts of increase or decrease depend on the pressure produced and also somewhat on the design of the fan.

### Outlet Diffuser

An outlet diffuser, as shown by the dashed lines in Fig. 5, is sometimes used in large vaneaxial fans. Its function is to provide for a gradual increase in the cross-sectional area toward the outlet, and consequently for a gradual decrease of the air velocity, hereby avoiding abrupt changes and improving the conditions of air flow with respect to the possibilities of reconversion from useless into useful energy. For best results, the outlet diffuser has the shape of a long cone with a rather small angle. Such a diffuser cone will increase the efficiency by about 4 to 6% and in the case of large units this difference may result in a considerable reduction of the motor horsepower.

The outlet diffuser has, on the other hand, the dis-

advantages that it makes the unit longer and that it reduces the motor cooling effect of the air stream and the accessibility of the motor. It is therefore often left out, especially in small and medium sized units. In very large units, however, where special provisions for motor cooling are made anyway, an outlet diffuser is usually included.

## Application

The problem of fan selection in general (considering all existing types including the centrifugal fan) usually presents itself in the following manner: Two variables, air volume and static pressure, are specified; three other variables, type, size and speed, are—for optimum conditions—to be selected.

Selection should be made in such a way that the combination of the five variables results in a unit that is suited for the duty specified. This can be checked by converting (according to the general fan laws) air volume and static pressure to a standard size and speed, for which a classification sheet has been made up. Fig. 22 shows such a classification sheet for fans of the axial flow type of 24-in. wheel diameter and 1750 rpm. The volume-pressure plane is here divided into five ranges; fans of the axial flow type are well suited for only four of them, as marked. Centrifugal fans are suited for the fifth range, but also for a good portion of the other ranges. The dividing lines are system characteristics similar to those in Fig. 18. They are here straight lines because of the logarithmic scales. They are to be considered as recommendations rather than as strict rules, as the individual ranges are widely overlapping.

It should also be determined that the unit has a proper aerodynamical load. The maximum load, or upper limit for good performance, is indicated by the dotted line in Fig. 22, but most designs will stay well below this maximum load. The minimum load is not indicated since the lower limit is not as critical as the upper limit.

Additional requirements of the particular application, such as cost, sound level, pressure safety margin, etc., must be met. Into this group will also belong certain requirements frequently affecting the decision between the vaneaxial fan and the centrifugal fan; the principal considerations used are listed.

The centrifugal fan has the following advantages over the yaneaxial fan:

(1) Natural adaptability to installations necessitating a 90° turn of the air stream.
(2) Better accessibility of the motor.
(3) Better protection of the motor against hot and contaminated gases.
(4) Better adaptability to installations with fluctuating system characteristic.

The vaneaxial fan has the following advantages over the centrifugal fan:

(1) Greater compactness.
(2) Straight line installation.
(3) Higher efficiency.
(4) Lower sound level at comparable size and speed.

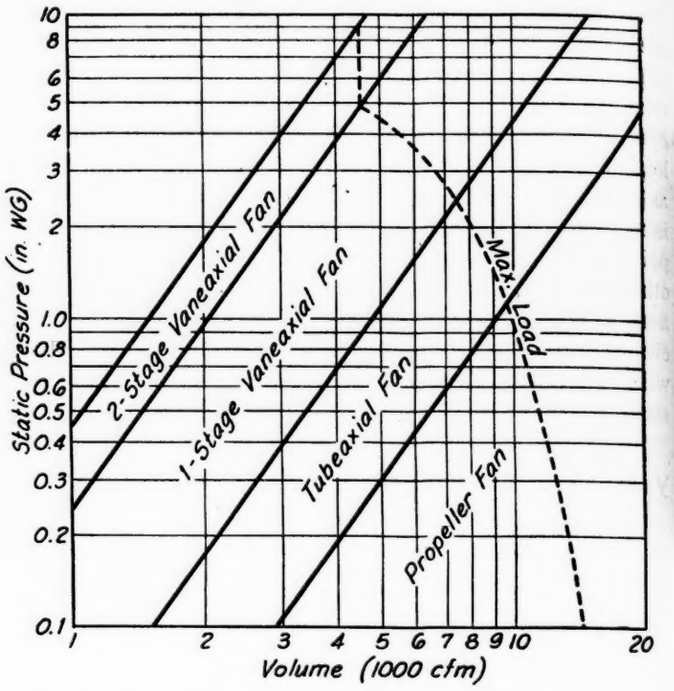



**Fig. 22. Operating range of axial flow fans. Classification sheet for 24 in. and 1750 rpm.**

The above tends to show that each of the different types has its definite place. It will also serve as a guide in the selection of fans, as illustrated by three examples:

(1) A fan should be selected that will deliver 10,000 cfm against a static pressure of 0.1 in. wg and that will be quiet enough for installation as an exhaust fan in a store. We select a 30-in. propeller fan at 855 rpm. Converted to the standard size and speed (24-in. and 1750 rpm), this fan would deliver 10,500 cfm against 0.27 in. wg. Fig. 22 confirms that the fan should be a propeller fan. If the fan were for installation in a factory, we could select a 24-in. propeller fan at 1750 rpm. This fan would be less expensive due to the smaller size and higher motor speed, but at the same time it would have a higher noise level due to the considerably higher tip speed.

(2) An inexpensive fan should be designed that will deliver 23,000 cfm against 2.5 in. wg. We elect to design a 36-in. tubeaxial fan at 1750 rpm. Converted to 24-in. and 1750 rpm, this fan would deliver 6800 cfm against 1.11 in. wg, which according to Fig. 22 falls well within the range of tubeaxial fans. If high efficiency would be more important than first cost, we would rather design a 36-in. vaneaxial fan at 1750 rpm.

(3) A vaneaxial fan for straight line installation should be designed that will deliver 2000 cfm against 5 in. wg. We decide on a 15-in. vaneaxial fan at 3450 rpm. Converted to 24 in. and 1750 rpm, this fan would deliver 4160 cfm against 3.3 in. wg, which, according to Fig. 22, is still within the vaneaxial fan range. If accessibility of the motor is more important than straight line installation, a centrifugal fan would be more suitable.

*The operating principles of centrifugal fans will be discussed by Mr. Bleier in a forthcoming issue.*

# Air Conditioning a Luxury Airliner

**Information gained during World War II helped designers to provide passenger comfort in Martin 202 airliner with air conditioning and warm wall heat.**

SINCE the end of World War II, many changes have been made in airplane designs and in equipment manufactured for airlines. None of the changes has been more important than those concerned with passenger comfort, such as air conditioning of the passenger cabin and plane compartments. Since air conditioning was practically a new field to aircraft designers, many new methods and types of equipment have been introduced. Typical is the installation being made on the new Model 202 luxury airliner being built by The Glenn L. Martin Co., Baltimore, Md.

For years aerial travelers withstood frequent temperature changes. Invariably those in the front seats near the heating duct outlets perspired while others in the aft section shivered. During flight, passengers were easy prey to discomfort and air sickness for they traveled in an improperly ventilated cabin in which stuffy, lifeless air accumulated quickly.

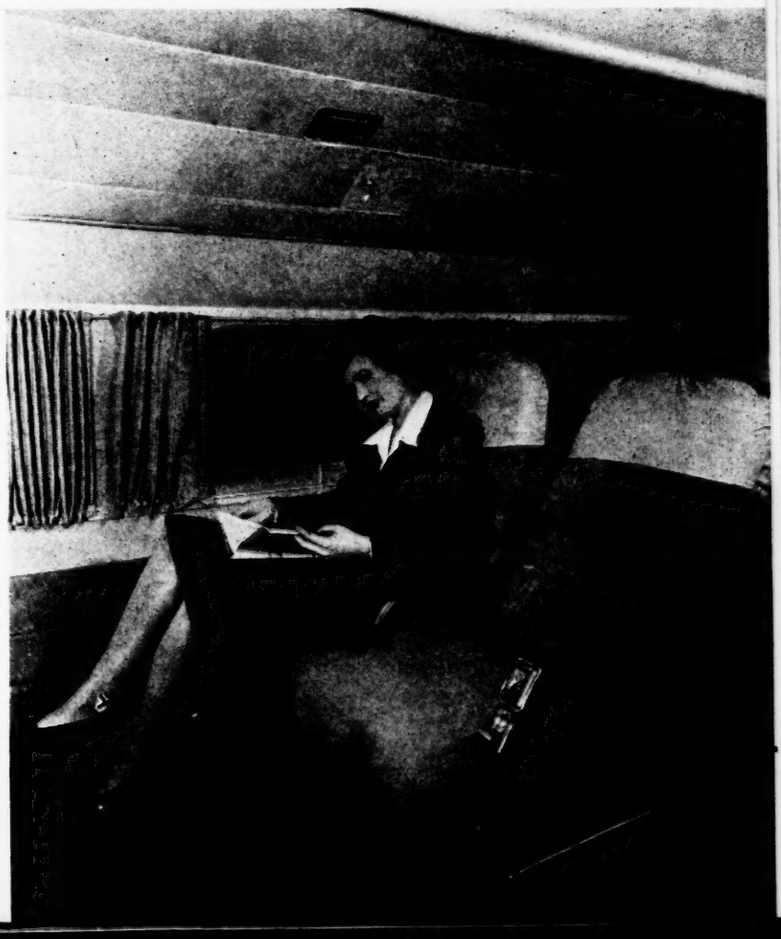
Information gained from the past war, plus close scrutiny of various other systems being developed, went into the designing of the Model 202 equipment, a system which provides complete ventilation both on the ground and in the air.

The ventilating system is actuated by a fan which automatically draws in air when the airplane speed falls below a predetermined point. For example should an airplane be standing at the end of a runway awaiting clearance, fresh air is circulated through the cabin and cockpit at the same rate as if the airplane were in flight. Therefore, even though in the broiling sun while on an airfield, the passengers are comfortable.

While in flight, when a preset speed is reached, the fan is shut off automatically and the air circulates because of the plane speed.

Several features of aircraft air conditioning are incorporated in Model 202. Conditioned air is brought through floor outlets at each inboard seat pedestal and is blown at a low velocity along the floor outboard. A warm wall is provided from the hat rack down to the floor line, while outlets above the hat rack supply tempered air to this zone to prevent air stratification, particularly when the airplane is on the ground and solar heat gain is at its maximum. The warm wall method distributes heat evenly over the inside of the

**Interior of Martin 202 airliner. Fresh air inlet grille is dark plate directly over passenger in front seat.**



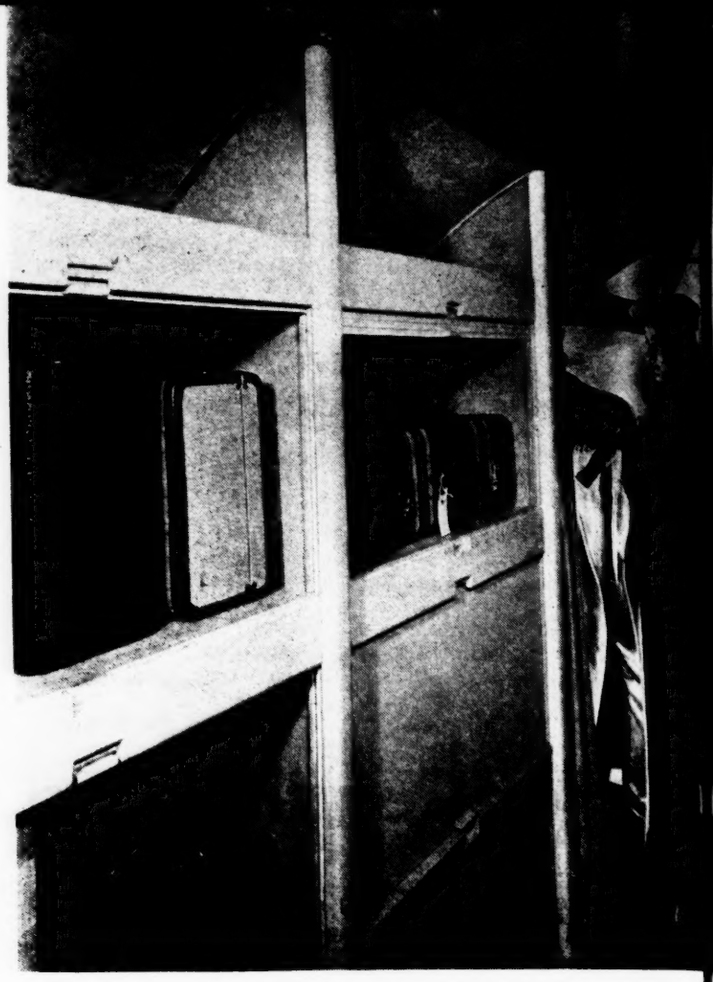
airplane instead of pouring it out through a few ducts in isolated areas of the passenger cabin.

The main ventilation ducts run through the hat racks. In some systems, under ordinary circumstances, while these in themselves might serve to heat the cabin, they are not sufficient for the Martin design. They would cause spotty conditions, foul air, and eventually air sickness.

Branch ducts also lead up to both sides of the hat rack from where the air bleeds between the inner wall and the outer skin thus heating the walls. This warm wall prevents heat radiation from the passenger's body to the cold outside wall.

The design is based on 28 cfm of air per passenger. Fresh air is taken in at the nose, passes through a combination rain trap and air filter, and from there through a combination heater (Stewart-Warner rated at 200,000 Btu per hr), when on the ground. Air for ventilation passes through the heater where it may or may not absorb heat, depending on the demand of the thermostatic cabin temperature control. There is a complete air change in the cabin more than once a minute.

To get rid of stale air from the passenger cabin a positive exhaust fan is installed in the aft baggage compartment. Air is drawn through floor grilles and exhausts into the tail of the airplane from where it is discharged through exhaust louvers. To maintain a positive air flow in the pilot's compartment, there is a grille in the cabin door.



Fresh air is provided in the luggage and coat compartments as well as in the passenger section. Note grille in wall behind passenger.

Looking towards the pilot's compartment from the stewardness section. Fresh air inlet grilles are in ceiling below hat racks.

Additional branch ducts lead to the cockpit, the double windshields for defogging, defrosting and deicing, and to the other compartments such as the baggage spaces, coat rack, galley and lavatory. In this way every crack and cranny of the airplane is reached by the heating and ventilating system.

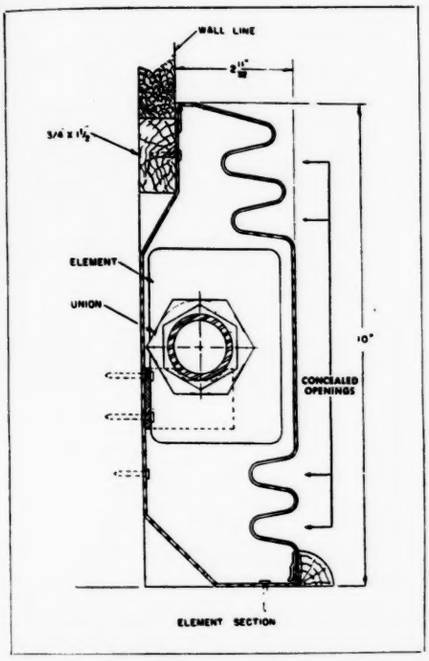
When deicing, the windshield heat is automatically increased by a booster tied into the wing deicing system that supplies hot air at approximately 180F. The pilot's and co-pilot's floor grilles have a manual control for adjusting airflow to the cockpit. Individually controlled fresh air outlets are provided for each passenger, pilot, co-pilot, and stewardess.

In operation, the heating system is turned on by the stewardess by means of a selector switch located in the galley, but from then on it is fully automatic by means of a thermostatic temperature control which maintains a cabin temperature of 75F when the outside temperature is —40F. Any malfunctioning of the system is indicated by a red signal light located adjacent to the galley switch. A manual control is provided in case of failure of the automatic control. Also provided is an emergency switch, with which the pilot can shut off the entire heating and ventilating system. In flight the heater will operate without the high pressure axial flow fan. For cooling when the airplane is on the ground, a connection permits attachment to a separate ground cooling unit.

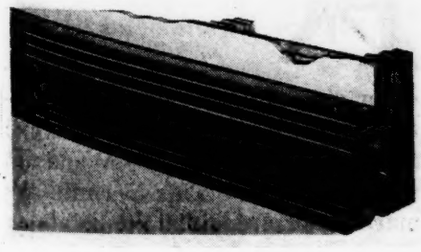
# NEWS OF EQUIPMENT AND MATERIALS

### Dunham Baseboard Simplicity Heating System

NAME—Dunham Baseboard Simplicity heating system.
PURPOSE — Hot water baseboard heating.
FEATURES—System consists of finned pipe elements covered by a steel




casing to form a baseboard radiator. Cover is easily removed so that parts are accessible for cleaning. Units are supplied in lengths of 2, 3, 4, 5, and 6 ft. Baseboard units to cover bare pipe only are supplied in 10 ft lengths which are cut to fit on the job. Inside and outside corner fittings and door stop fittings are supplied complete. No bare pipe or pipe fittings are supplied. Can be used with hot water systems with hot water temperature ranging from 160 to 220F



but 180F is recommended to avoid charring of dust particles in air.
SIZES AND CAPACITIES—Range from 740 to 2755 Btu per hour for 24 in. cabinet length and 72 in. cabinet length, respectively, at 180F water temperature.
LITERATURE AVAILABLE — Bulletin 639.
MADE BY—*C. A. Dunham Co., 450 E. Ohio St., Chicago 11, Ill.* .....**165**

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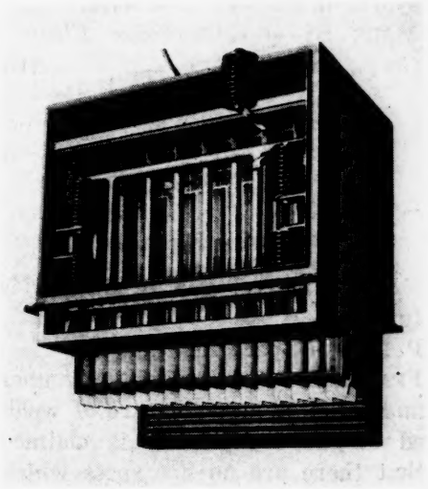
### Railroad Electro-Airmat

NAME—AAF Railroad Electro-Airmat.
PURPOSE—For air cleaning in railroad car applications.
FEATURES—Unit has collector element of electrostatically-charged paper. Arrestance rating when tested by the discoloration test method is 90% or better with atmospheric dust and smoke. Is said to be exceptionally compact, requiring 30% less space and 40% less weight than electronic filters with metal plate collectors, so that unit is paticularly applicable to light weight and simplified railroad cars. Electro-airmat is trade name



for a cellulose product filter element which is arranged in jackstraw form. Spare elements, mounted with clean airmat can be provided at terminal points for quick servicing. Loading is simply by turning a mechanical crank and requires two minutes per element. For small installations manual loader answers the purpose but for either type casters can be furnished for loading at the track side if necessary.
SIZES AND CAPACITIES — Available in two types, type RS and RB for side and bottom servicing, respectively; collector element 19½ x 26½ x 7 in. is interchangeable. Rating is 950 cfm per unit. Operates on 115 volt, 60 cycle, single phase current; power consumption 250 watts, 350 watts maximum load.
MADE BY — *American Air Filter Co., 215 Central Ave., Louisville 8, Ky.* .....**166**

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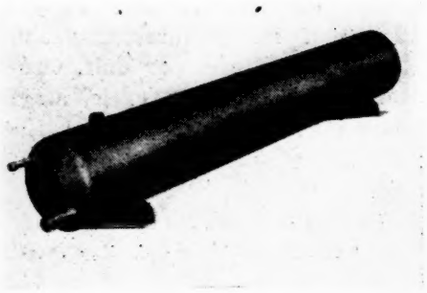
### Air Vent

NAME—Curtis Air-Vent.
PURPOSE—For relieving air from hot water radiators, convectors, panel radiation or pumps.
FEATURES—When air is accumulat-

ed in radiators or pipe lines it can be quickly released by finger tip pressure on the push button of the air bleeder valve. Air and water are deflected downward. Wher water starts running it is an indication that all the air has been released and the pressure should be removed from the push button. Valve is machined from brass and contains a stainless steel spring and temperature tested synthetic rubber seal.
SIZES AND CAPACITIES—Valve has standard ⅛ in. pipe thread and 7/16 in. hex. head.
MADE BY—*Curtis Automotive Devices, Inc., 8 Norwood Ave., Dayton 7, Ohio.* .....**167**

### Chiller

NAME—Trane dry expansion-type chiller.
PURPOSE—For cooling non-corrosive liquids.



FEATURES — Unit provides chilled water for comfort and process air conditioning systems and can be used to cool other liquids such as brine, denatured alcohol, ethylene glycol, and other fluids having the characteristics of water.
SIZES AND CAPACITIES—For water or brine flow, available from 4 to 300 gpm in a wide variety of sizes.
MADE BY — *The Trane Company, LaCrosse, Wis.* .....168

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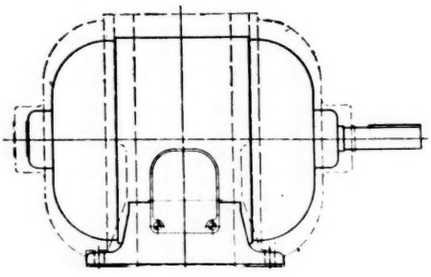
### Induction Motor

NAME—Life-Line.
PURPOSE—To provide square type motor of smallest size and lighter weight than customary units of same capacity.
FEATURES — Motor is more than 35% smaller in size than the line of Westinghouse motors that it replaces. Starting torques have been increased as much as 134% per lb of motor and maximum torques



increased as much as 116% per lb of motor. Squirrel cage motor has bearings which, it is said, will not require attention for at least five years. Vibration and noise have been reduced to new low limits. The use of steel instead of cast iron has succeeded in reducing the weight of the motor and increasing its strength. Comparative motor sizes are of 7½ hp ratings as shown in the drawing. Dotted lines indicate outline of old model as compared to the solid line for the present size. Size reduction has resulted largely

from elimination of superfluous cast iron. Sizes of electrical working parts have remained substantially the same. Winding materials are of synthetic resin-covered wire.
MADE BY—*Westinghouse Electric Corp., Buffalo, N. Y.* .....169

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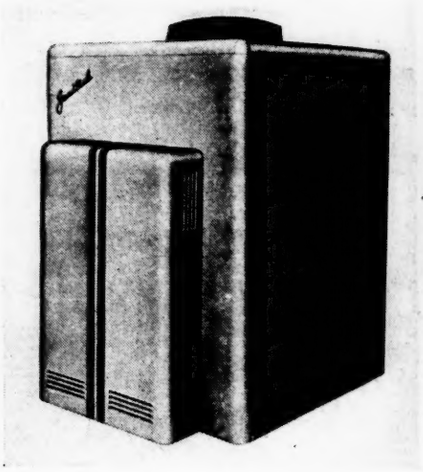
### Gravity Furnace

NAME—Janitrol gas fired gravity furnace.
PURPOSE—Space heating.
FEATURES — Combustion chamber and radiator assembly are of welded 18-gauge steel. It is claimed that there are no hot spots which would create stresses in construction. Standard equipment includes a flame retention type burner with a special alloy flame diffuser and a venturi to insure the proper mixture of air and gas. A burner air duct directs secondary air to the burners. Controls include a low voltage magnetic valve and transformer, thermostat, quick acting automatic pilot and adjustable gas pressure regulator. All controls are concealed behind the front panel. Positive ignition of the pilot gas is obtained by a separate transformer which supplies constant voltage.



SIZES AND CAPACITIES—Units of 75,000 and 100,000 Btu capacities.
MADE BY — *Surface Combustion Corp., Toledo 1, Ohio.* .....170

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### Protractor

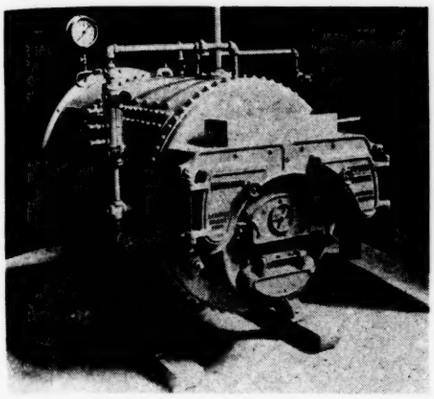
NAME—Center-finder protractor.
PURPOSE—For angle measurement and for marking points on the circumference of a pipe in layout work.
FEATURES—Tool is made of heat-treated magnesium. Retractable center punch slides freely in the frame. One side of the center finder consists of a double-reading degree scale with two frame witness marks which permits the use of this tool as a 360 degree protractor. On the

other side is a nest of 4 levels, rotating in conjunction with the dial and registering with the V and flat side of frame. This permits the marking of 4 equidistant points on the circumference of a pipe.
MADE BY—*Interstate Sales Co., 1121 Broadway, New York 10, New York.* .....171

### Scottie Junior Boilers

NAME—Kewanee Scottie Junior boiler.

PURPOSE—For generating high pressure steam for dry cleaning



establishments, laundries, creameries, dairies and various industrial plants.

FEATURES—This line represents a new line added to the company's portable return tubular Scotch marine type. Construction is of flanged steel shell, cylindrical shape, one longitudinal joint, double riveted, double butt strap, 3 in. 12 gage stainless steel tubes, cast iron doors, portable inexpensive setting; bottom blow-off. Coal grates are stationary; for oil or gas, front furnace extension has refractory nozzle.

SIZES AND CAPACITIES—Available in six sizes from 6 to 30 hp or from 840 to 4200 sq ft of radiation at 100 lb. working pressure.

LITERATURE AVAILABLE — Catalog 99-D.

MADE BY—*Kewanee Boiler Corp., Kewanee, Ill.* .....**172**

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### Temperature Recorder

NAME—G. E. type CF-2 inkless temperature recorder.

PURPOSE — To record temperature in refrigerating machines, air ducts, liquid handling systems, heat treating tanks, and ovens.

FEATURES—Designed for use with resistance temperature detectors already installed in generators, transformers and other electrical apparatus. Consists of portable recording instrument and external power-supply unit. Equipment records by an inkless recording mechanism, on a 4-inch strip chart, temperature variations that produce resistance changes in standard, ten ohm resistance temperature detectors heretofore used mainly with indicating instruments. External power unit contains constant voltage d-c source, a part of the bridge

circuit, and lead-resistance compensating device.

SIZES AND CAPACITIES—Range of the fixed scale and chart scale on the recorder is 20C to 140C. With a chart length of 65 feet, driving motor can be adjusted to provide record length of from eight days to two years on a single chart. Weight of recorder is 11 lb. Dimensions are 7¼ x 5 x 4-1/16 in. Weight of power unit is 5 lb. Dimensions are 9¾ x 7⅜ x 6 in.

MADE BY—*Meter and Instrument Division, General Electric Company, Schenectady 5, N. Y.* .....**173**

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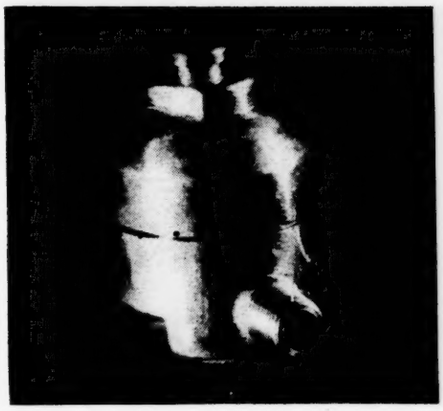
### Air Eliminator

NAME—Risselt J-Z air eliminator valve.

PURPOSE—To remove entrapped air from steam heating systems.

FEATURES—Basis of the unit is a thermal bellows filled with a volatile liquid that is sensitive to heat and cold. When steam vapor enters the valve, the bellows expands and the valve is closed. When the system chills off, bellows contract, valve is opened and air is expelled. Valve is made of brass in top and bottom pieces, which are carefully machined.

LITERATURE AVAILABLE—Illustrated folder.



MADE BY—*The Lodge & Shipley Machine Tool Co., 800 Evans St., Cincinnati 4, Ohio.* .....**174**

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### Air Conditioner

NAME—Gemco two-stage air conditioner.

PURPOSE — For general space air cooling.

FEATURES — Cooling coil is of all copper construction and has a large face area four rows deep to provide maximum moisture removal. Filter is of all metal construction. The compressor is constructed of heat treated aluminum alloy and is designed for direct connection to the motor. Compressor and motor are semi-hermetically sealed into a compact unit. Compressor has four cylinders counter balanced and is two-stage for quiet and smooth operation. Heat is transmitted to the condenser and this eliminates the need for a water cooled motor. Entire cabinet is insulated with lightweight fibre glass which acts both as heat insulation and provides acoustical properties. Moving parts are pressure lubricated and the oil is supplied by a direct driven multi-directional pump on the bottom of the compressor crank case.

MADE BY—*General Engineering & Manufacturing Co., 1523 So. Tenth St., St. Louis 4, Mo.* .....**175**

### Vacuum Cleaner

NAME—General Industrial Vac.
PURPOSE—To convert blower unit into a heavy duty vacuum cleaner.
FEATURES—Vacuum unit consists of a metal vacuum tank, a double hose connection, filter bag, and an agitating plunger. With this, the blower unit is used in reverse. It

is designed for use for cleaning up a customer's premises, after an insulation job.
MADE BY—*General Blower Co., 8066 Ferris, Morton Grove, Ill.* .....**176**

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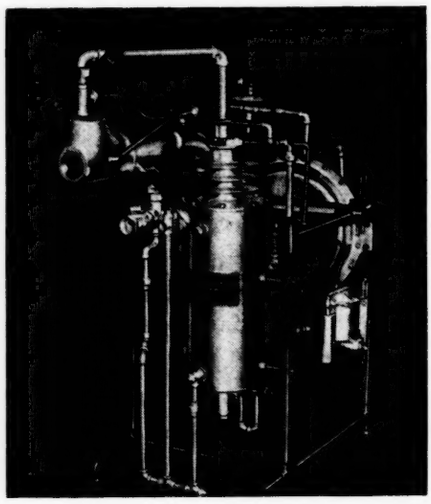
### Vapofier

NAME—Vapofier.
PURPOSE—Oil generating unit that provides vapor which is then mixed with air and piped, burned and controlled in the same manner as gas.
METHOD OF OPERATION—Fuel oil is maintained at constant level in combustion chamber by float valve. Products of combustion are drawn through surface of oil in combustion chamber, heating oil to vaporizing temperature. Vapor thus created is drawn off through premixer where proper fuel-air ratio is established and maintained. Combustible mixture is then piped to burners. Fuel-air ratio may be predetermined and maintained throughout entire range of capacity. Device is efficient utility gas pre-mixer. By closing valve to combustion chamber, utility gas is mixed with air in proper ratio. In



event of gas cut off or failure, device using fuel oil may be cut in without loss of flame at burners.
SIZES AND CAPACITIES—Eight standard sizes with capacities from 70,000 Btu per hour on ½ gallon per hour of oil to 2,000,000 Btu per hour on 14 gallons of oil per hour. Occupies 2 × 4 feet of floor space.
MADE BY—*Vapofier Corp., 10316 S. Throop St., Chicago 43, Ill.* .....**177**

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### Speed Nuts

NAME—Series C7000 speed nuts.
PURPOSE—Low priced line of heat treated spring steel nuts covering ten most popular sizes of machine screws and sheet metal screws.

FEATURES—Compact, designed to withstand high torque tightening and greater tensile strength than flat type speed nuts.
MADE BY—*Tinnerman Products, Inc., 2010 Fulton Rd., Cleveland 13, Ohio.* .....**178**

### Float Valve

NAME—CRC-246 float valve.
PURPOSE—Float valve designed for use with vaporizing burners.
FEATURES—Valve connects directly to the burner nipple and provides a constant oil flow regardless of inlet head variations. Design makes possible setting bottom of fuel sup-

ply tank flush with top of the valve. Unit will meter flows as low as 1 cc per minute. Flow comes out of center of float chamber to offset possible error due to meter being set out of level. Makers claim accurate registration even with a 5 degree tilt.
MADE BY—*Detroit Lubricator Co., 5900 Trumbull Ave., Detroit 8, Mich.* .....**179**

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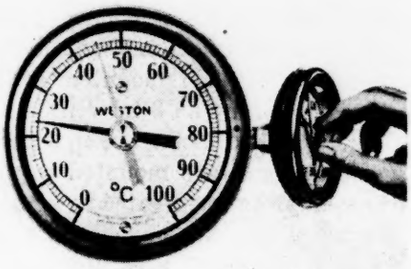
### Drawing Pad

NAME—Jiffy sketch.
PURPOSE—Drafting device for making rapid sketches.
FEATURES — Drawing pad consists of 75 sheets of tracing tissue, enclosed within a jacket that is provided with four cardboard flaps. Various scales are printed on three of the flaps. To use the pad one of the cover flaps is folded underneath the tracing tissue and whatever scale is selected shows through the paper. In this way graphs, isometric drawings, and other sketches can be made rapidly. The pad measures 9 x 12 in. and the sheets are perforated for easy removal.
MADE BY—*Jiffy Sales Co., 1830 E. 37th St., Cleveland 14, O.* .....**180**

### Thermometer

NAME—Weston max-min thermometer.
PURPOSE—For indicating the high or low temperatures reached during an operating period.
FEATURES—Similar to the standard Weston all-metal thermometer except that it has an auxiliary red index which is manually set by a finger knob that protrudes from the center of the glass scale. When a




record of the lowest temperature is desired, the index is placed to the low side of the temperature pointer. The pointer will move the index to the lowest temperature reached during any operating period. The index will remain at the low point until manually reset. To show the highest temperature reached, the index is set to the high side of the pointer.
SIZES AND CAPACITIES—Comes with 3- and 5-in. diameter scales and in stem lengths from 2½ to 48 in.
MADE BY—*Weston Electrical Instrument Corp., Newark, N. J.* .....**181**

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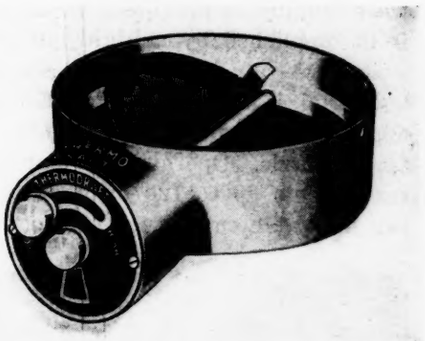
### Damper Control

NAME—Thermodraft.
PURPOSE—Damper control through thermostatic means.
FEATURES—A flue damper is operated by means of a bi-metal coil which is affected by temperature changes of room and chimney flue. It is adjustable to provide any degree of heat required. While designed particularly for coal or wood-burning stoves and ranges it can also be used on some furnaces. It is installed in any convenient joint in the chimney-pipe and does



not require any special fittings or electrical connections.
SIZES AND CAPACITIES—Made for pipes of 6, 7, and 8 in. diameters.
MADE BY—*No-No Specialty Co., Quincy Ave. at 69th St., Cleveland, Ohio.* .....**182**

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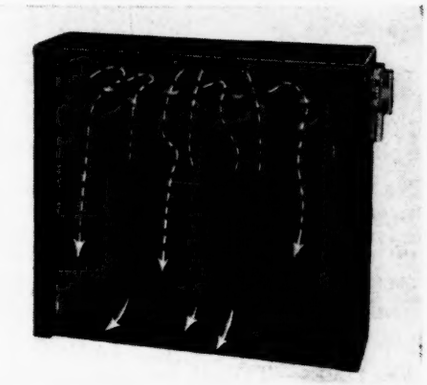
### Air Conditioner

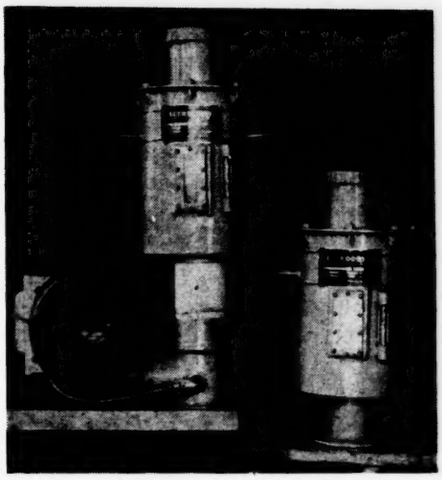
NAME — Amcoil comfortair conditioner.
PURPOSE — For creating room comfort by removing humidity from air.
FEATURES — A cooling coil inside the cabinet creates a low vapor



pressure area. Moisture laden air enters the unit and is attracted to this low pressure area through small openings in the coil enclosures. Moisture is condensed and is drained off. Moisture-free air mixes with cooled air below the coil and is discharged into the room. This flow continues as long as the vapor pressure difference prevails. Unit is available in two floor models.
LITERATURE AVAILABLE—Illustrated bulletin.
MADE BY — *American Coils Co., 25-27 Lexington Street, Newark 5, N. J.* .....**183**

### Lectrobreathers

NAME—Lectrobreathers.
PURPOSE—To prevent atmospheric moisture from entering storage tanks.
FEATURES—Incoming air is dried by passage through activated aluminas in breather. Can be mounted directly over tank vent or pipe to it. Equipped with color indicator to determine when reactivation is



needed or is complete. Illustration shows breather on left being activated by electrically-powered reactivating unit.
SIZES AND CAPACITIES—Several factors must be considered before a specific size or type is installed, including frequency and speed of emptying tank, capacity of tank, nature of tank's contents, and weather conditions.
MADE BY—*Pittsburgh Lectrodryer Corp., Pittsburgh, Pa.* .....**184**

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### Roof Coating

NAME—Richlume.
PURPOSE—To provide reflective insulation for roof coating.
FEATURES—Reflective coating is applied with brush or spray to tar and gravel tar paper, built-up asphalt, or composition shingle roofs. Insulating qualities are such, it is said, that 80% of the sun's rays are reflected. The roof coating is claimed to be flexible so that it can expand and contract with the roofing material.
MADE BY—*The Richkraft Co., 228 No. La Salle, Chicago 1, Ill.* .....**185**

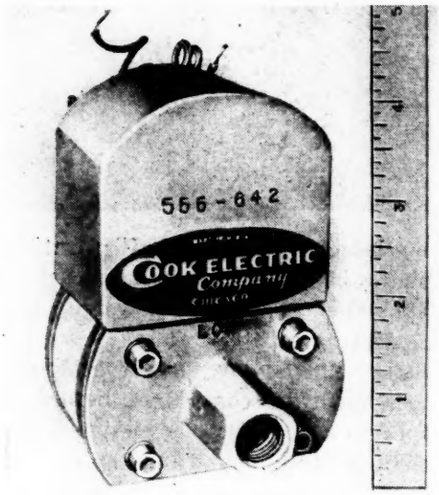
### Pressure Switch

NAME—Cook PD pressure difference switch.

PURPOSE—Used where it is desirable to operate a circuit on difference between two pressures, either gas or liquid.

FEATURES—Snap-on cover, switch mechanism mounted externally to machined steel bellows housing. All metal parts cadmium plated.

SIZES AND CAPACITIES—Pressure connections ¼ in. standard female pipe thread. Operates on pressures from 0 to 50 lb per sq in. Pressure difference between high pressure side and low pressure side may be specified anywhere between 5 and 30 lb per sq in. Switch will accom-




modate maximum surge pressure of 500 lb per sq in. on either side without affecting calibration.

MADE BY—*Diaphlex Division of Cook Electric Company, Chicago 14, Ill.* .....186

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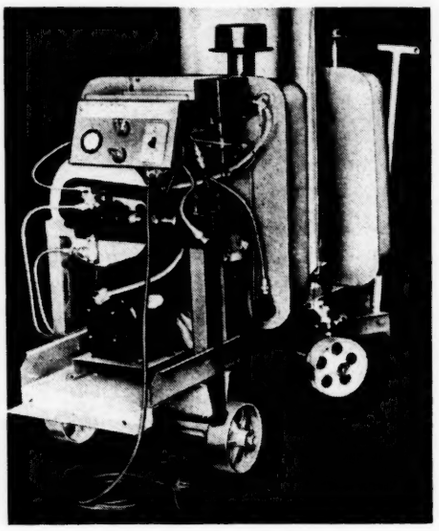
### Steam Cleaner

NAME—Model JO Hypressure Jenny instantaneous steam cleaner.

PURPOSE — For the generation of high pressure steam for use in cleaning machinery, walls and floors.

FEATURES—Cleaner is portable and is mounted on a wheeled platform. Oil or gas-fired units are optional and the only requirements for operation are that an electric current outlet and a hose connection to water supply be provided. Cleaning is accomplished by a highly atomized mixture of steam, hot water and a cleaning compound that is applied under pressure through a spray nozzle. Operating pressures range from 80 to 120 lb at 90 gal per hr water capacity. Overall di-



mensions of unit are 55 x 28 x 47½ in. and the weight is 520 lb.

MADE BY—*Homestead Valve Mfg. Co., Coraopolis, Pa.* .....187

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### Oil Burner

NAME—Arc-Heat industrial burner.

PURPOSE—For efficient burning of oil in industrial plants. Besides steam boilers, its uses include annealing ovens, metal melting, and process work.

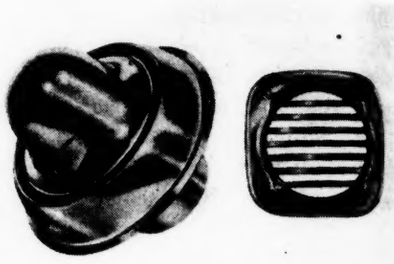
FEATURES—The oil, by collision with air or steam, is atomized and is then sprayed into the fire box. Air is drawn in at speeds for proper combustion. No blowers are required to feed secondary air. A modulating valve within the unit can restrict the size of the flame and therefore the amount of oil used. One lever controls the modulating valve and the free air intake. Modulation can be so fine that it must be dialed by micrometer apparatus for equipment such as annealing ovens requiring precision adjustment.

MADE BY — *American Heat Corp., Lawrence, Mass.* .....188

### Kitchen Ventilator

NAME—Kitchen-Aire ventilator.

PURPOSE — For removing cooking odors and fumes from kitchens.



FEATURES—Grille is mounted in the ceiling above the range, and is connected to the fan mounted on the outside wall, by an 8 in. ventilating duct. Fan and motor are in a metal enclosure and are mounted outside the wall. Fan is operated by a ¼ hp motor which, it is said, can handle 20 sq ft of canopy area.

MADE BY—*Stewart Mfg. Co., 3209 E. Washington St., Indianapolis 1, Ind.* .....189

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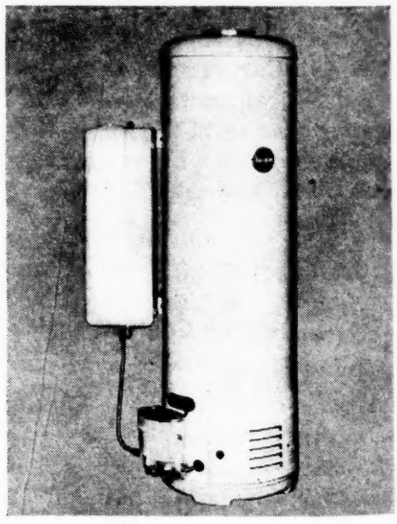
### Water Heater

NAME—Duo-Therm water heater.

PURPOSE—For providing hot water.

FEATURES — A five-gallon oil tank

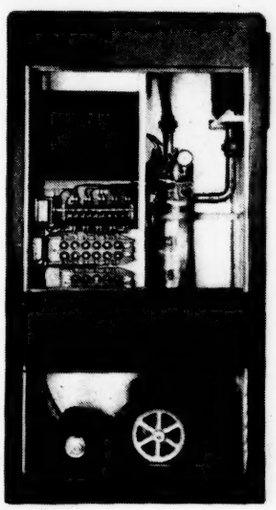


is provided for the oil heater where a large fuel oil tank is not available, and it is attached to the side of the water tank. The tank is finished in white enamel.

MADE BY — *Duo-Therm Division, Motor Wheel Corporation, Lansing, Mich.* .....190

### Electric Heating

NAME—Cronholm Vap-O-Lec.
PURPOSE — House heating by electrical means.
FEATURES — Hermetically sealed generator contains emersion type low voltage heating coils encased in copper tubes with a small amount of water sealed in under reduced pressure. This arrangement produces superheated steam which circulates through copper heat transfer coils. Cold air is drawn in from the top of the cabinet by a circulating fan mounted on the bottom of the unit, and passes through filters. It is then forced upward, is heated, and discharged to the rooms. Makers claim that heat is produced within 30 seconds and within 3

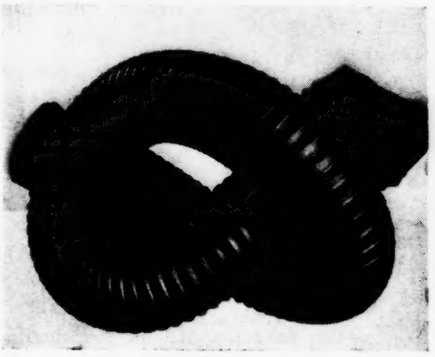


minutes it is operating at full efficiency. Flow of energy into the coils is limited by pressurestat control.
LITERATURE AVAILABLE—Illustrated folder.
MADE BY—*The Cronholm Mfg. Co., 3500 S. E. Hawthorne Ave., Portland 15, Ore.* .....191

---

### Flexible Hose

NAME—Continuous wind process hose.
PURPOSE—To provide a flexible hose for ventilating work and for use in fume and dust control.
FEATURES—Hose utilizes a lightweight spiral wound reinforcement. Neoprene precoated fabric is used and a new process enables manufacture of continuous hose lengths in diameters from 1 to 24 in. Cuffs, bushes, reducers, flanges or fittings of special shape can be attached to



a hose length if required.
MADE BY—*American Ventilating Hose Co., 25 Park Row, New York 7, N. Y.* .....192

---

### Gruv-Seal Rings

NAME—Gruv-Seal rings.
PURPOSE—Forged gasket for valves, valve bonnets and flanged connections for high pressure and high temperature pipeline use wherever ready dis-assembly is necessary.
FEATURES—Forged of different materials to meet different service requirements, these gaskets provide for making a connection by wrench pressure said to be as tight as a weld. Forged in closed impression

dies, they are then machined to insure exact dimensions.
SIZES AND CAPACITIES — Available in two types, type O, oval, and type X, octagon, in a range of sizes, including all standard API sizes.
MADE BY—*The Steel Improvement & Forge Co., 790 E. 64th St., Cleveland, Ohio.* .....193

---

### Cutting Tool

NAME—Airco 13-in. cutting torch.
PURPOSE—A short cutting torch to permit repair of fire tube boilers in cramped quarters.
FEATURES—Torch can be provided with a 45, 75 or 90 degree bronze head. Makers claim that this torch permits workmen to operate in confined space, often as little as 12 in. deep. Oxyacetylene torch is adaptable for the removal of worn tubes from the larger types of heating boilers.
MADE BY—*Air Reduction Company, 60 E. 42nd Street, New York 17, New York.* .....194

October, 1946

## TO OBTAIN FURTHER INFORMATION ON NEW EQUIPMENT

**On the list below, circle the item number of the equipment in which you are interested, using the number found at the end of each item.**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 165 | 166 | 167 | 168 | 169 | 170 | 171 | 172 |
| 173 | 174 | 175 | 176 | 177 | 178 | 179 | 180 |
| 181 | 182 | 183 | 184 | 185 | 186 | 187 | 188 |
| 189 | 190 | 191 | 192 | 193 | 194 | | |

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# Abstracts AND Reviews

## THERMODYNAMICS

A well balanced treatment of the subject for use in a two-semester undergraduate course. Ideal gas laws, available and unavailable energy, and entropy have been treated at considerable length. A chapter on the fundamentals of heat transfer is included. ASA standard symbols have been used wherever possible.

*Thermodynamics, by George A. Hawkins. Price, $4.50. Cloth bound, size 5½ x 8½, 436 pages, includes charts, illustrations and tables. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y.*

## SAFETY PROVISIONS

Those interested in safety control and management will find the first annual edition of Best's Safety Directory of interest and value.

The book presents data on over 1,000 products, devices and equipment used in safety, first aid, hygiene, health conservation and fire protection. It tells what safety product to use, when to use it, how to use it and where to purchase it. A comprehensive index lists sales offices and distributors, and the safety products.

*Best's Safety Directory. Cloth bound, 8 x 11 in., 351 pages. Published by Alfred M. Best Co. Price, $5.*

## WARM AIR PANEL HEATING

Probably the most unpublicized phase of radiant heating is that involving warm air rather than hot water as the heating medium. Several investigators have done considerable work along these lines and prominent among them is the staff of International Heater Co., Utica, N. Y., whose ideas have been embodied in a number of actual installations the first of which was made in 1938.

The system developed by this company, and called the Panelaire system, is patented but now available under license for use with any make or type of heating unit. To assist contractors and engineers who desire to install such system, H. F. Randolph, vice-president of International Heater, has prepared a calculation, design and installation manual covering this system, now available under the title "Panelaire—The Warm Air Panel Heating System."

Included are sections on advantages, precautions, detailed step-by-step procedure for calculation and design accompanied by tables for saving time in computation, suggested specifications, a well-illustrated section showing details of construction, together with plans for eight actual installations with comments emphasizing special features of each.

The author is to be complimented on covering his subject in well organized and concise form, the latter objective being attained, however, without slighting any important phases of the subject. The manual is highly recommended.

*"Panelaire—The Warm Air Panel Heating System," by H. F. Randolph. Paper-bound, 8½ x 11 inches, 36 pages. Published by Sheet Metal Publication Co. Price, $1.00.*

• • •

STOKER MANUAL—The fourth edition of the Stoker Manufacturers Association Information Manual contains a list of members, committees, officers, publications and by-laws. It includes a roster of stoker manufacturers, company officials, the types of units produced by each company. Copies at 50 cents each are available from Stoker Manufacturers Association, 307 N. Michigan Ave., Chicago 1, Ill.

COAL RESEARCH—The report points out that investigations are being carried out in six laboratories and experiment stations in different parts of the country, and by work at private mines and by private operators. The bulk of the work is concentrated at the Central Experiment Station, Pittsburgh and Bruceton, Pa. The report discusses properties of coal, combustion, carbonization and gasification. For a free copy of Information Circular 7367, "Coal Research Activities of the Bureau of Mines," write to the Bureau of Mines, Dept. of the Interior, Washington 25, D. C.

PUBLIC HOUSING DESIGN—The entire scope of community development from preliminary surveys through planning and actual construction is covered in a 300-page book issued by the Federal Public Housing Authority. Among the subjects discussed are general considerations of project design, site selection, planning and engineering, dwelling types and plans, community buildings, service structures, materials, utilities, mechanical and electrical design, lawns and plantings. A number of photographs, diagrams and charts are used for illustrations. This book is expected to be of value to commercial home builders. For copies of "Public Housing Design" at $1.25 each, write to the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

OVERFIRE AIR JETS—An 8-page paper bound folder entitled "Have You Considered Overfire Jets for Smoke Abatement?" by William S. Major of Bituminous Coal Research, Inc., and giving a complete outline of methods, equipment requirements and data for determining sizes of overfire air jets for increasing secondary air with the objective of reducing smoke.—Available without cost from *Bituminous Coal Research, Inc., 912 Oliver Building, Pittsburgh 22, Pa.*

# NEWS OF THE MONTH

## GAS AND WARM AIR

**lead in fuel and type of heating system planned for houses built under Veterans Emergency Housing Program.**

A study of the heating and fuel planned for 629,000 dwelling units authorized between January 15 and July 26 under the Veterans Emergency Housing Program shows that gas leads in the choice of builders for fuel for heating, 52% of the applications calling for this fuel. Coal (27%) and oil (21%) follow in that order, according to the National Housing Agency. About 93% of the applications were for conventional single-family units; the remaining 7% were for multi-family units.

• **HEATING TYPES.** — In types of heating systems selected by applications, warm air led with 50% of all applications, 51% of single family applications. Table 1 summarizes data on the type of system (overflow heaters include floor furnaces, wall furnaces and space heaters).

**Table 1 — Distribution of Type of Heating for VEHP Houses**

| Heating System | % of all Applications | % of single-family house applications |
|---|---|---|
| Radiator heating | 17 | 15 |
| Forced warm air | 25 | 26 |
| Gravity warm air | 25 | 25 |
| Overflow heaters | 33 | 34 |

**Table 2 — Type of Heating Used with Various Fuels in VEHP Houses**

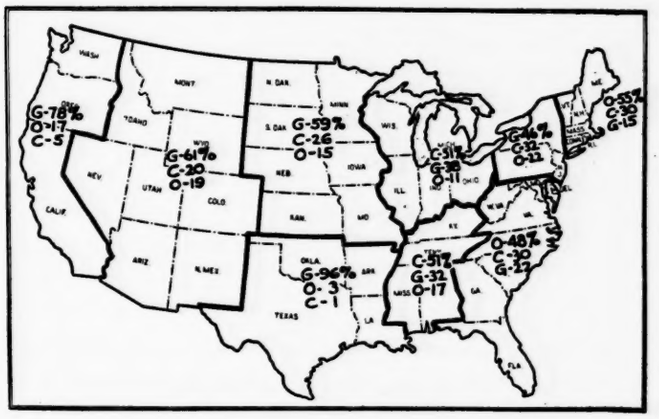
| Fuel | Radiator Heat, % | Forced Warm Air, % | Gravity Warm Air, % | Overflow Heaters, % |
|---|---|---|---|---|
| Coal | 33 | 20 | 46 | 17 |
| Oil | 37 | 28 | 8 | 15 |
| Gas | 30 | 52 | 46 | 68 |

**Table 3 — Type of Radiator Heat in VEHP Single- and Multi-Family Units**

| Heating Medium | Multi-Family, % | Single-Family, % | Total, % |
|---|---|---|---|
| Steam | 35 | 45 | 44 |
| Hot water | 65 | 55 | 56 |

The proportions in which the various fuels will be used by each type of heating system are shown in Table 2. Division of steam and hot water radiator systems between single and multi-family units is shown in Table 3.

• **DISTRIBUTION.**—Distribution of fuel preference by geographical regions is shown on the accompanying map. Total heating equipment requirements of the program for the last six months of 1946 and all of 1947 are shown in Table 4. In addition to single and multi-family conventional units, the requirements chart reflects the needs of the entire program including conversions of existing structures into additional living accommodations; the program to reuse surplus war housing in temporary units; factory-made houses, and trailers. It is assumed the type of equipment used in the last six months of 1946 and 1947 will follow the pattern set in the first six months of this year.




Distribution of fuel preference.
Legend: G = gas; O = oil; C = coal.

**Table 4 — Estimated Heating Equipment Requirements for VEHP Houses to End of 1947**

| Type of Equipment | Last 6 Mo., 1946 | Total Year, 1947 |
|---|---|---|
| | Number of Units Required | |
| Coal boilers | 25,000 | 52,000 |
| Oil boilers | 28,000 | 57,000 |
| Gas boilers | 22,000 | 46,000 |
| Coal furnaces | 84,000 | 209,000 |
| Oil furnaces | 46,000 | 115,000 |
| Gas furnaces | 125,000 | 311,000 |
| Coal overflow heaters | 32,000 | 80,000 |
| Oil overflow heaters | 147,000 | 174,000 |
| Gas overflow heaters | 316,000 | 716,000 |
| Radiators and convectors (1000 sq ft) | 19,365 | 35,765 |
| Oil storage tanks | 170,000 | 280,000 |
| Controls (separate items) | 1,550,000 | 3,500,000 |

# MOTOR STANDARDS

**adopted by NEMA for single-phase fractional horsepower motors to reduce costs and improve application efficiency.**

Application engineers concerned with fractional horsepower motors for oil burners, stokers, condensing units, pumps, fans, and blowers are affected by a broad new program of standardization for fractional horsepower motors, designed to reduce production costs, insure efficiency and proper application in use, and result in long term savings to customers, announced September 10 by members of the motor and generator section of the National Electrical Manufacturers Association. The new NEMA standards are of importance to engineers, contractors, and others in appraising motor performance in terms of nameplate rating and motor application.

• **DEFINITIONS.**—The new standards provide specific definitions of motor rating and performance in coordinated terms of horsepower rating, speed, breakdown torque, and service factor. In formulating the standards, the motor manufacturers felt that a clearly defined and generally accepted method of evaluating motor performance was essential to assure intelligent design, manufacture and use of small power motors. The fundamental points covered in the standards include not only this new basis of rating, but also previously standardized locked rotor or starting currents of motors. It was emphasized that this was but the first phase in the new program of standardization, and would be followed later this year by other items of standardization such as dimensions, and application standards for hermetically-sealed motors, belt-drive refrigeration compressor motors, machine, stoker, oil burner, belted-fan-and-blower motors, shaft-mounted fans and blowers, and cellar drainer motors.

• **IMPROVEMENT.** — In the past the horsepower stamped on a fractional horsepower motor plate has not always been a true indication of the motor's load carrying ability since no adequate standard had previously been established to define horsepower rating in terms of speed and torque. Because of this lack of uniformity in rating, the motor of one manufacturer might drive a machine while a motor of the same type and horsepower rating of another manufacturer might fail to operate it satisfactorily. The manufacturer who used small power motors as a component of his product was constantly required to test each manufacturer's motors on his device in order to determine their suitability. These new standards should remedy this.

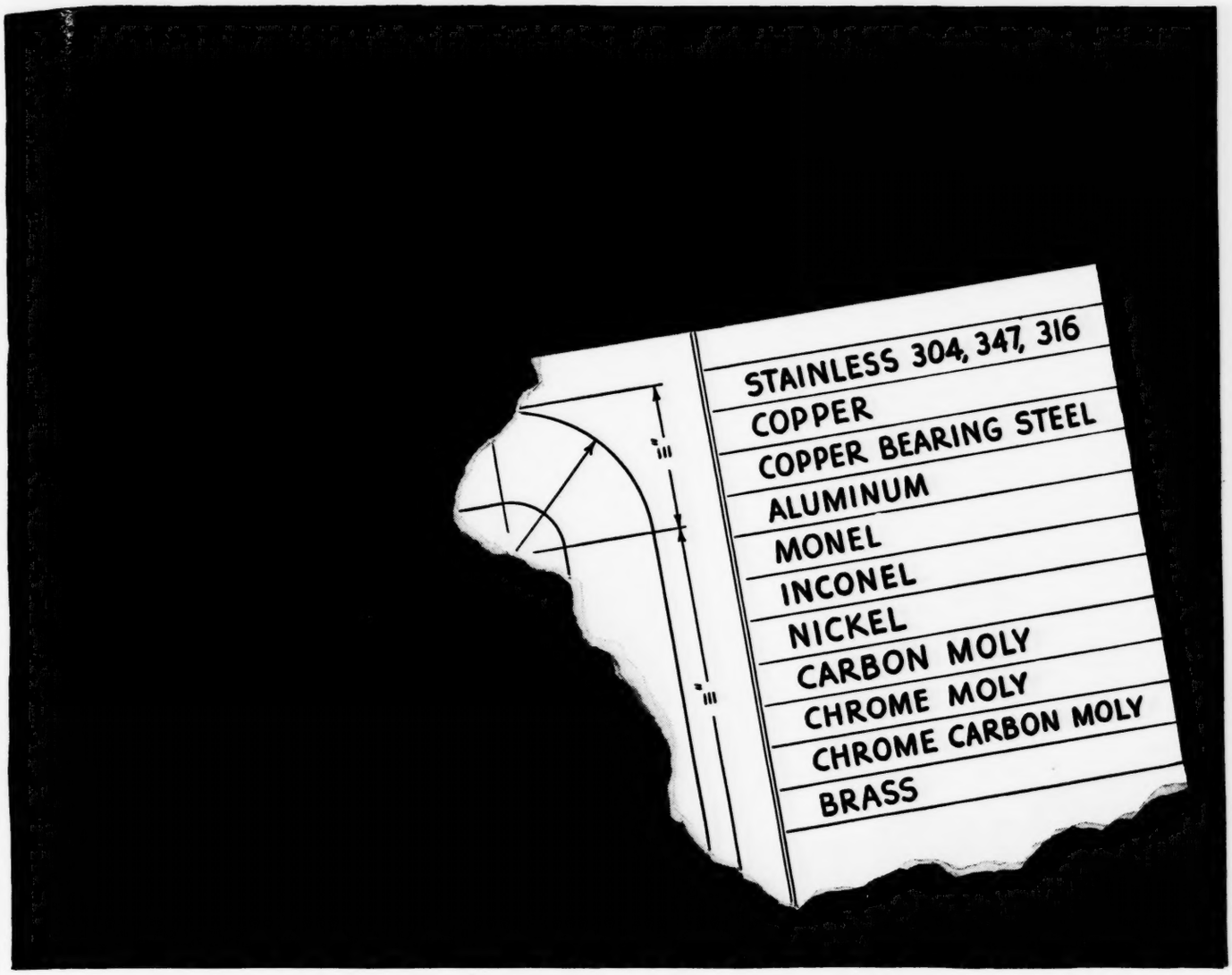
A summary of the points covered in the new standards relating to rating, service factor and starting currents follows. Standards relating to motors for special uses, such as in the appliance field, will be released in November and December.

• **DATA.**—In the application of fractional horsepower induction motors, the motor should be selected with a breakdown torque which is sufficient to take care of the maximum peak load requirements of the application. Breakdown torque is the maximum torque which the motor will develop without an abrupt change in speed. In order that the new standards would be inclusive and serve to provide a definition of rating of any particular motor design, the complete range of breakdown torque was divided into bands for the various standard horsepower ratings. Such a series of torque values associated with corresponding horsepower rating provides a definite classification of any motor in terms of horsepower ratings.

**Table 1—NEMA Standards for Breakdown Torque, Single-Phase Fractional Horsepower Motors**

| Synchronous R.P.M. | | | | | | Brake Hp. Rating |
|---|---|---|---|---|---|---|
| 3600 | 3000 | 1800 | 1500 | 1200 | 900 | |
| Approx. Full Load R.P.M. | | | | | | |
| 3450 | 2850 | 1725 | 1425 | 1140 | 850 | |
| Breakdown Torque, Ounce-Feet† | | | | | | |
| 2.0- 3.7 | 2.4- 4.4 | 4.0- 7.1 | 4.8- 8.5 | 6.0-10.4 | 8.0-13.5 | 1/20 |
| 3.7- 6.0 | 4.4- 7.2 | 7.1-11.5 | 8.5-13.8 | 10.4-16.5 | 13.5-21.5 | 1/12 |
| 6.0- 8.7 | 7.2-10.5 | 11.5-16.5 | 13.8-19.8 | 16.5-24.1 | 21.5-31.5 | 1/8 |
| 8.7-11.5 | 10.5-13.8 | 16.5-21.5 | 19.8-25.8 | 24.1-31.5 | 31.5-40.5 | 1/6 |
| 11.5-16.5 | 13.8-19.8 | 21.5-31.5 | 25.8-37.8 | 31.5-44.0 | 40.5-58.0 | 1/4 |
| 16.5-21.5 | 19.8-25.8 | 31.5-40.5 | 37.8-48.5 | 44.0-58.0 | 58.0-77.0 | 1/3 |
| 21.5-31.5 | 25.8-37.8 | 40.5-58.0 | 48.5-69.5 | 58.0-82.5 | — | 1/2 |
| 31.5-44.0 | 37.8-53.0 | 58.0-82.5 | 69.5-99.0 | — | — | 3/4 |
| 44.0-58.0 | 53.0-69.5 | — | — | — | — | 1 |

†Breakdown torque range includes the higher figure, down to, but not including the lower figure.

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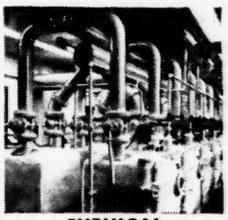
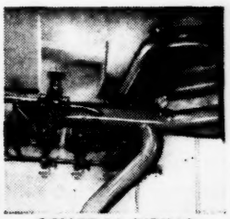
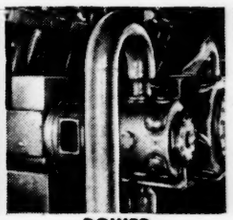
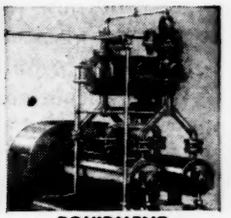

CHEMICAL


GENERAL PIPING

SHIPBUILDING


POWER


EQUIPMENT

The values shown in Table 1 are the newly adopted NEMA standards for breakdown torque of single phase fractional horsepower motors.

Fractional horsepower motors of the open 40C rise continuous rating, referred to as general purpose motors, have a lower temperature rise rating than certain motors designed for specific duty and load conditions which are rated 50C rise (open) or 55C rise (totally enclosed). These temperature rises are recognized by industry as the maximum compatible with long insulation life.

The users of fractional horsepower motors, when applying open 40C rise motors on specific applications and known load conditions have recognized that these motors may be safely operated continuously at loads greater than the horsepower rating on the nameplate. It became apparent that motor users desire recommendations from the motor manufacturers regarding the safe continuous overloads which would give the maximum safe operating temperatures of the open 40C rise motors, considering the inherent 10C margin of safety of these motors. This inherent overload ability is referred to as service factor.

Fractional horsepower motors, due to their physical size and value of breakdown torque related to full load torque, as compared with motors of larger rating, have a higher overload ability than indicated by 1.15 service factor of the larger ratings.

The service factors, recently adopted as standards by NEMA, and given in Table 2, have been determined to define the loading that will give a total temperature rise of 50C on a general purpose fractional horsepower motor having 40C rise at the nameplate rating.

It will be noted that these service factors go up as far as 1.4 which means a 40C motor having a 1.4 service factor may be operated at 140% load continuously.

**Table 2 — Service Factors for General Purpose 40C Induction Motors**

| Rated Horsepower | Service Factor |
|---|---|
| 1/20 | 1.4 |
| 1/12 | 1.4 |
| 1/8 | 1.4 |
| 1/6 | 1.35 |
| 1/4 | 1.35 |
| 1/3 | 1.35 |
| 1/2 | 1.25 |
| 3/4 | 1.25 |
| 1 (at 3600 rpm only) | 1.25 |

The temperature rise on which the nameplate rating is based shall be no more than 40C for all coil windings. This low limiting temperature rise is provided to allow a greater factor of safety where the service conditions are unknown.

When authorized by the manufacturer such a motor may be operated (at rated voltage and frequency and in an ambient temperature not exceeding 40C) at a continuous load greater than rated load determined by the above service factors.

**Table 3 — Starting Currents for Single-Phase Fractional Horsepower Motors**

| Rated Horsepower | Voltage | |
|---|---|---|
| | 115 | 230 |
| | Starting Current, Amperes | |
| 1/6 (and smaller) | 20 | 10 |
| 1/4 | 23 | 11.5 |
| 1/3 | 31 | 15.5 |
| 1/2 | 45 | 22.5 |
| 3/4 | 61 | 30.5 |

The maximum locked rotor current standard is not new, having been adopted by NEMA several years ago. The standard provides that the locked-rotor current (starting current) of 60 cycle, single phase motors, (900-3600 rpm range) of any type (except those split-phase motors at present used on washing machines and ironing machines) shall not exceed the values given in Table 3.

## FAIR TRADE PRACTICE

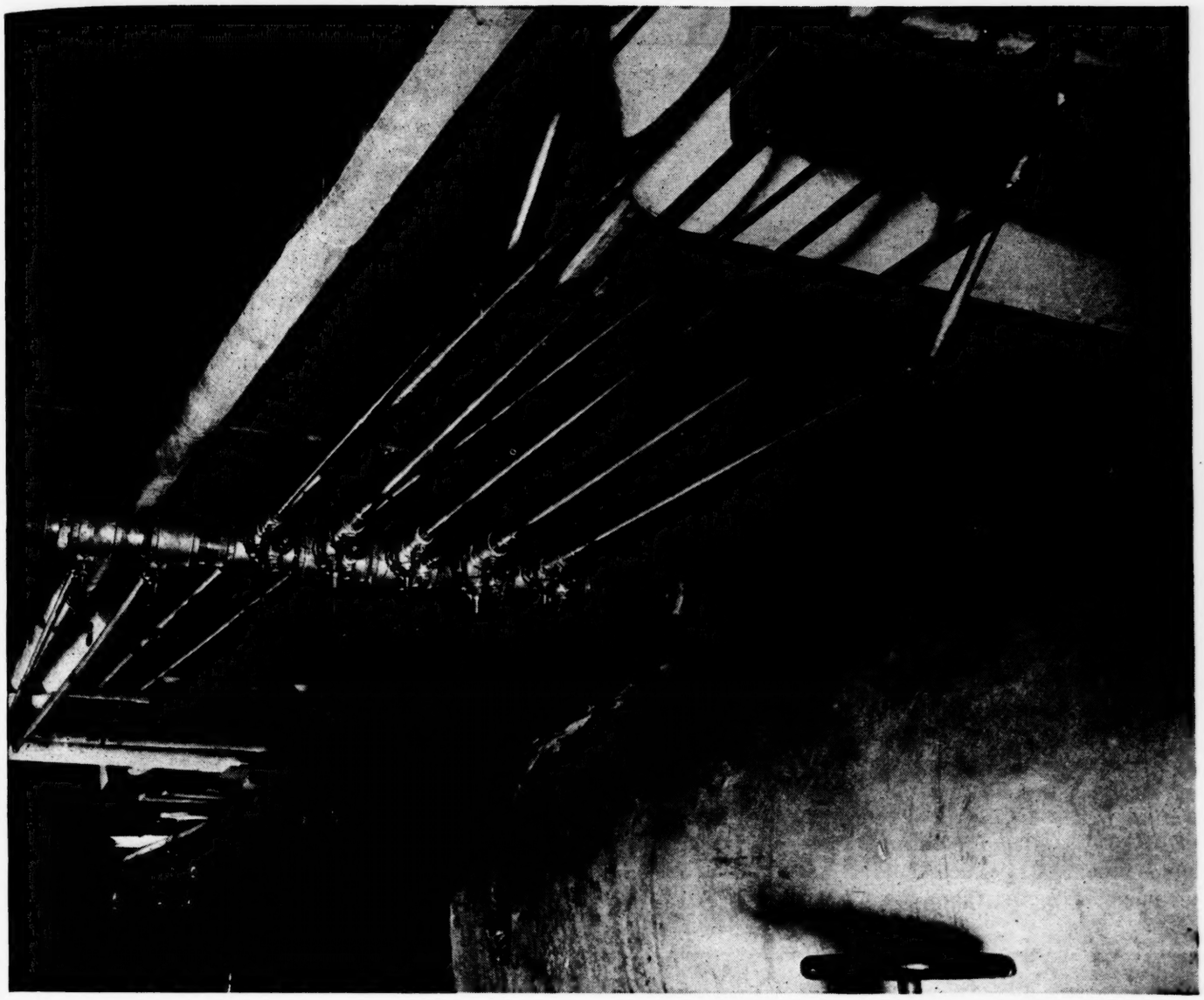
**Procedure sharply changed by Federal Trade Commission; industry to set up its own rules, FTC prosecute violators.**

Hearings, complaints, "cease and desist" orders, and other activities of the Federal Trade Commission have been news in few industries for years, one reason being that FTC action against industry has been sporadic and hit-or-miss. An FTC case, however, was bad news to the defendant, for even if handled informally it took about 14 months to settle, while a formal hearing case took 26 months, and cost the defendant several thousand dollars as well as worry and trouble.

• **NEW PLAN.** — Beginning in August, a complete change in 30-year-old FTC policy was inaugurated. Sources close to the White House say the President is responsible for the new Federal Trade Commission program, and that at his insistence the Commission is being transformed from an antagonist to a friend of business. Under the new plan, FTC will not take action against individual firms on receipt of a complaint; instead it will call for a trade practice conference in that industry, allow that industry to establish its own rules in language which it understands. After approval of such rules by a majority of the industry, FTC will proceed against violators as a group, the violators being those who refused to go along with their own industry's rules.

• **ADVOCATE.**—Principal advocate for the new plan of operation is Commissioner Lowell B. Mason, appointed by President Truman. He bases his arguments for the new plan on the following premises:

(1) Most people are honest; (2) most business firms



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are honest, too, and most violators of fair trade practices do so because a minority force them into such practices to defend themselves; industry itself is the best judge of fair practice in its own field; (3) fair trade practices vary sharply from industry to industry; (4) government can't possibly police all industry effectively but it can (5) proceed against violators of industry's own rules if industry cooperates and (6) industry will cooperate in enforcing rules it made itself.

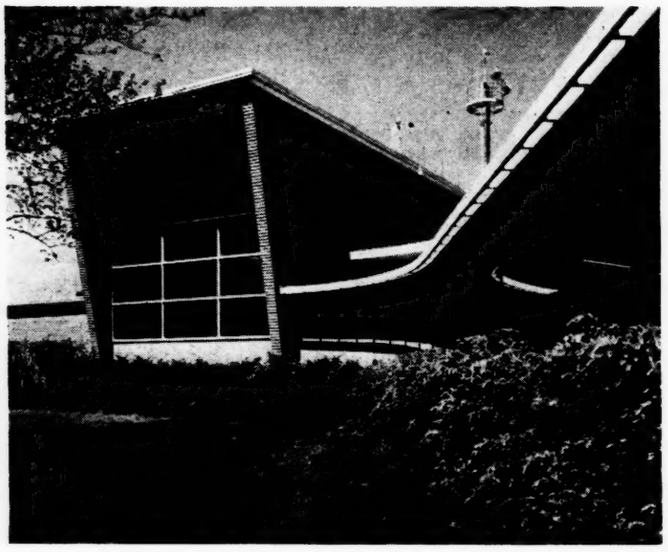
Some Washington observers believe that this realistic but not-too-well publicized change in policy is a hopeful sign, anticipate that industry will cooperate fully with FTC so as to pave the way for similar trends among certain other agencies.

## SPLIT HEATING SYSTEM

**featured in new electrical laboratory employs both radiant and warm air types of heating.**

For the $100,000 Benjamin Electric Mfg. Co. laboratory, designed by Perkins & Will, Chicago architects and engineers, E. R. Gritschke, Chicago mechanical engineer, designed the full heating and air conditioning system, which employs both radiant floor coils and hot air from the air conditioning system during the heating cycle.

• **CONTROLS.**—The radiant system is governed by an outdoor thermostat which shuts off the water-circulating pump whenever the outdoor temperature reaches



**Note overhang designed to shield large glass area in summer and admit sun in winter.**

a point where heating is no longer required. The same instrument readjusts a thermostat which controls the temperature of the water for the radiant heating system. Thus the temperature of the hot water rises automatically as the weather becomes colder, and falls as the outdoor temperature modulates.

• **HOT AIR.**—The ventilating system is used for hot-air heating to supplement the radiant system during the heating cycle. Its instantaneous response helps overcome any possible lag in response to rapid temperature changes. The split system, according to Mr. Gritschke, combines the best features of both types of heating, while keeping the cost of the radiant portion at a minimum.

All air supplied to the photometric laboratory and the general working areas of the building is completely controlled in temperature and in humidity. The controls go to work automatically whenever one of the three supply fans is started. The thermostat for each fan system, set at 50F in the outdoor and return air mixing chamber, determines the relative amount of outdoor and return air which is used by operating a suitably arranged set of dampers.

• **HUMIDITY.** — A humidostat automatically controls the amount of relative humidity in each of the areas served by a supply fan, with safety control so that there is no humidifying effect when the supply fan is not running. In addition to the humidity control, the air for each fan is under complete temperature control, with the same equipment regulating both cooling and heating cycles. Disposable Fiberglas filters are used.

## DEVELOPMENT OF SOUTH

**seen by ACRMA executive as southern industry responds to extended use of air conditioning.**

An outstanding industrial development is in prospect for the South due to the technological advances in the increasing use of air conditioning, which place that section on a basis of full climatic equality with northern industry, according to a report by William B. Henderson, executive vice-president of the Air Conditioning and Refrigerating Machinery Association. Mr. Henderson's report was presented to the board of directors of the association at their fall meeting in Hot Springs, Virginia.

• **SURVEY.**—The report contained a survey of southern industry's present situation and prospects and pointed to the industrialization of the South as one of the probable outcomes of various influences, chief among which is air conditioning.

The growth of air transport, development of natural resources, availability of new power sources, and advancement of education standards all contribute toward making industrialization feasible while air conditioning of working atmospheres is the final and key development opening what Mr. Henderson terms the "remaining frontier of this country."

• **AGRICULTURAL.**—Due to climatic conditions, says Mr. Henderson, the South has remained principally an agricultural economy. This situation has been similar around the globe with industry concentrated in the more temperate zones. Tropical goods have been taken north for processing and even cotton for a long period was made into finished articles largely in the

# DUST-STOP Air Filters used in Dual heating system

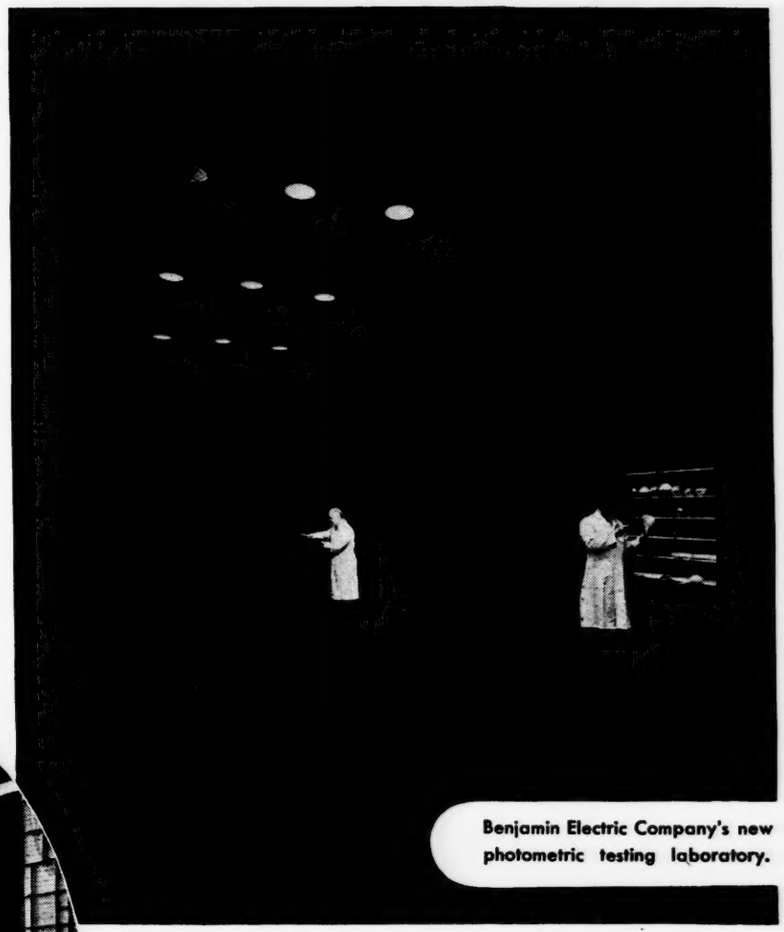
In the new Benjamin Electric Manufacturing Company Laboratory at Des Plaines, Illinois, the heating system employs both radiant floor coils and warm air from the air-conditioning system during the heating cycle. The dual system, according to its designer, combines the best features of both types of heating, while keeping the cost of the radiant portion to a minimum.

DUST-STOP Air Filters are used in this modern commercial heating and ventilating system. The DUST-STOP is a replaceable type air filter. Packs of adhesive-coated Fiberglas fibers provide an efficient medium for catching and holding most atmospheric and manufactured dusts.

Be sure to have complete information on DUST-STOP Air Filters for new or existing systems. Write for booklet "Air Filtration in Central Systems" (A5.2.1) Owens-Corning Fiberglas Corporation, Dept. 912, Toledo 1, O.

*In Canada: Fiberglas Canada Ltd., Toronto, Ontario*

Perkins & Will, architects-engineers. E. R. Gritschke, mech. eng.
All photos by Hedrick-Blessing Studio.



Benjamin Electric Company's new photometric testing laboratory.

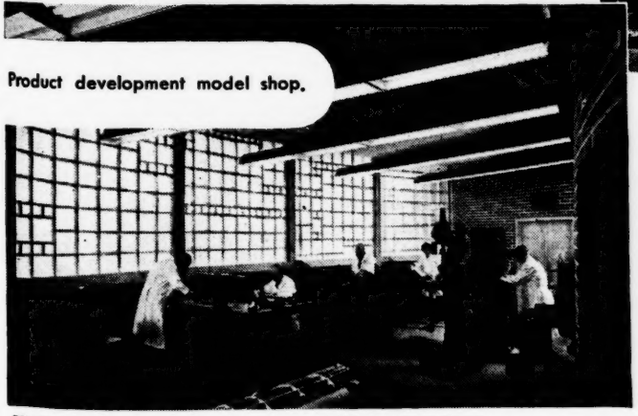
As demonstrated by their use in Benjamin Electric's new laboratory, DUST-STOP Air Filters are adaptable to the smallest and largest commercial and industrial heating and ventilating systems.

Triple-utility conference room.

DUST-STOP Air Filters may be installed in custom-built or the complete, ready-to-assemble DUST-STOP steel frame cells. The cells can be built up into filter banks *to handle any cfm* of air required.

Southern elevation of product development and testing laboratory.

Maintenance of the air filtration system is easy and economical. Replacement DUST-STOPS are readily available from authorized suppliers in nearly every community.



Product development model shop.

More and more engineers are specifying DUST-STOPS because of the efficiencies obtained both at low initial and low maintenance costs. Be sure to write for booklet A5.2.1 today.

**DUSTOP***

*T. M. REG. U. S. PAT. OFF.

*Air Filters*

A FIBERGLAS* PRODUCT

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**planned for business section of Detroit to house 756 cars. Cost set at $3,000,000.**

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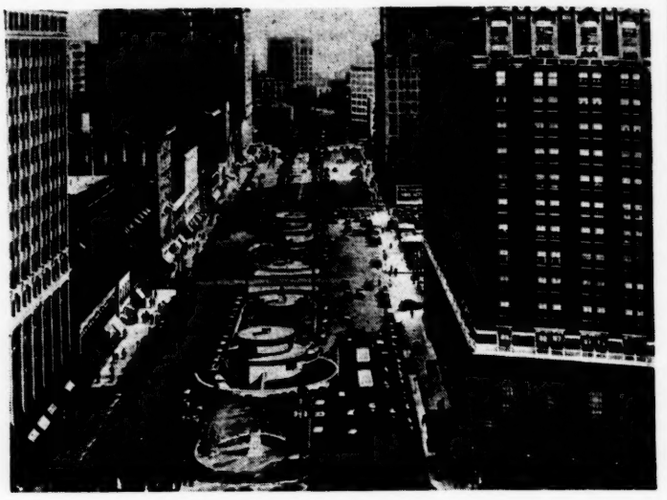

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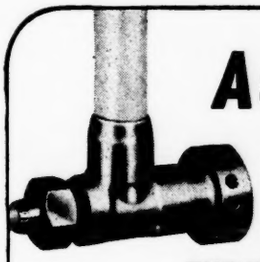

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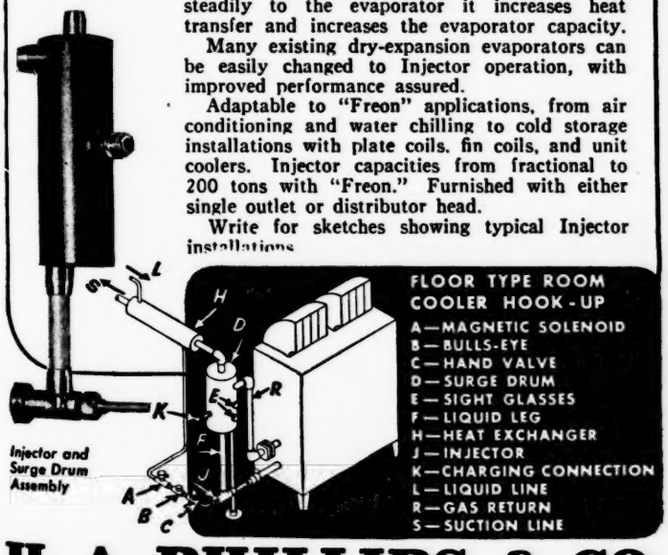


Injector and Surge Drum Assembly

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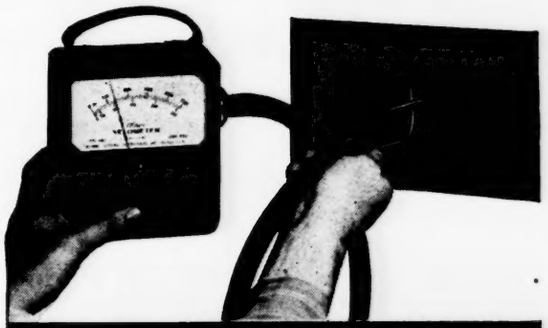
**H. A. PHILLIPS & CO.**

3255 WEST CARROLL AVENUE • CHICAGO 24, ILLINOIS



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**The Velometer is made in several standard ranges from 20 fpm to 6000 fpm, and up to 3 inches total pressure. Special ranges available as low as 10 fpm and up to 25000 fpm velocity and 20 inches pressure. Write for bulletin with complete data.**

**ILLINOIS TESTING LABORATORIES, INC.**
420 NORTH LA SALLE STREET
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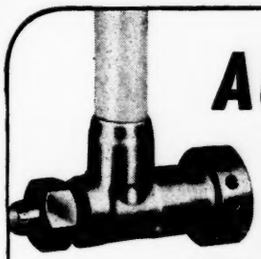

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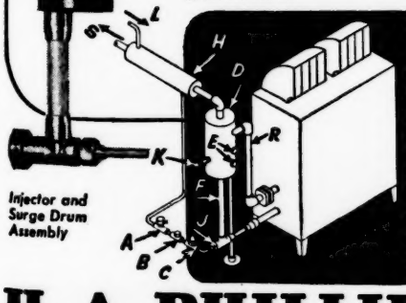


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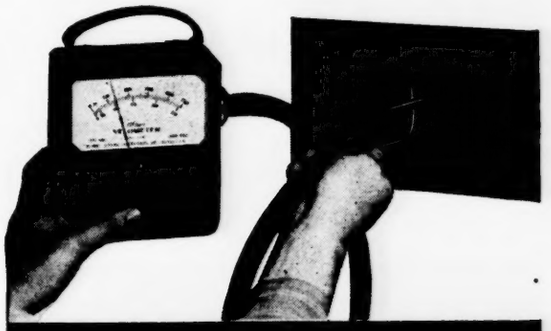

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pressors will be tried aboard the U. S. S. Newport News, now being built at Newport News, Va.

Results of these first installations will be studied for future application of cooling equipment on combatant ships.

• **COMPLETE.**—Except for the machinery spaces, virtually all living and working compartments aboard the new cruisers will be air conditioned. The ships are scheduled for completion in late 1947.

Vice-Admiral E. L. Cochrane, U. S. N., chief of the bureau of ships, emphasizes that the Navy is "not trying to mollycoddle its personnel." The systems, he says, are designed to increase fighting efficiency and improve living conditions.

Although the Salem and the Newport News will be the first completely air conditioned combat ships, the Navy points out that cooling systems aboard its ships date back more than 40 years.

---

## PASSENGER COACHES

**featuring new details in air conditioning are put in service by New York Central.**

New railway passenger coaches representing new developments in air conditioning techniques have been built by Pullman-Standard Car Manufacturing Co. and are rolling over the tracks of the New York Central System.

• **FEATURES.**—Many new features and appointments were incorporated into the car specifications. Of particular interest are the air conditioning units produced by Frigidaire Division of General Motors, which provide control of air temperature, humidity and circulation under variable conditions of weather and train mobility. Each car system is complete in itself, operated independently of outside power or control. Electricity for operating all units of the system is furnished by a direct current generator, which is driven by a power take-off on one side of the car axles. The generator produces 20 kw when the car is moving at normal speed. Only about 10 kw are consumed by the air conditioning system when it is operating at full capacity. Excess current is directed into the batteries where it is stored for use when the train is stopped or driven at reduced speed.

The compressor unit consists of a four-cylinder, vertical reciprocating type compressor, driven with multiple V-belts by a special 12 hp d-c electric motor. The entire unit is suspended on rubber for shock reduction and is easily accessible for service and maintenance.

• **CONDENSER.**—Comprised of two copper fin-and-tube coils and cooled by two fans driven by a single electric motor, the condenser unit is separated from the compressor to afford the maximum accessibility and efficiency. A liquid refrigerant receiver is mounted between the two condensers and serves as a support for the motor. A sight glass provides a quick check on refrigerant charge.

Generators, compressor and condenser units are suspended below the car on vibration-proof and shock-absorbing mountings. The air conditioner itself is installed above the ceiling at one end of the coach and includes two centrifugal type fans powered by a 1 hp motor, a cooling unit, a heating unit, and necessary controls. The fan assembly is completely insulated from the rest of the unit by means of rubber cushions and flexible ducts. Thus, an exceptionally quiet operation is realized.

The cooling unit is of the "multipath" type, equally distributing its refrigerant through a number of parallel passages and providing uniform cooling and dehumidifying throughout. Aluminum fins are closely spaced on large diameter copper tubes. The tubes, themselves, are staggered, creating a turbulence which assists the heat transfer. A steam coil located directly behind the cooling unit supplies heat when required. A drip pan and drain carry away the condensate.

Outside air is inducted into the system through filters and enters the conditioning unit along with filtered recirculated air from the car. The air is blown across the cooling and heating surfaces and is discharged into the length of the car — above the ceiling. Directional outlet grilles distribute the conditioned air uniformly about the passenger compartment.

• **CONTROLS.**—Automatic controls maintain desired temperatures with little, if any attention. A unique feature of the Frigidaire system is the modulation arrangement. When temperatures within the coach have been reduced to the proper level, the compressor and condensing unit continue to operate at reduced speed instead of cutting out completely. This modulation arrangement prevents condensed moisture in the cooling unit from being evaporated into the air stream during the period when no additional cooling is required. The result is more uniform comfort for the passenger.

---

## PARTS DISTRIBUTION

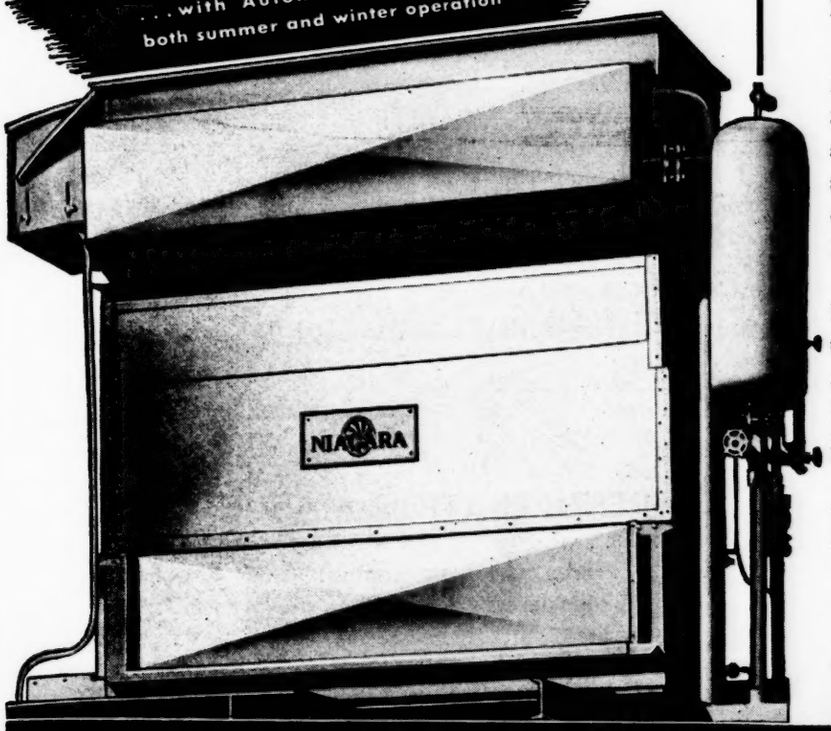
**facilitated by held-over wartime system of refrigeration wholesalers.**

A wartime system set up within the refrigeration industry to insure fast parts distribution is still in use and proving its value during peacetime shortages of refrigeration parts.

• **NETWORK.**—The system consists of a nation-wide network of refrigeration wholesalers and parts depots. Organized to maintain proper refrigeration facilities and prolong the life of existing equipment, the system operated during the war through the cooperation of members of the Refrigeration Equipment Wholesalers Association and nearly 200 manufacturers. The members of the Association agreed to maintain evenly dis-

## THE NEW AERO-PASS CONDENSER

. . . with Automatic Control for both summer and winter operation




**TO INCREASE YOUR PLANT OUTPUT OF PRODUCT, FIRST OPEN THE BOTTLE-NECK OF REFRIGERATION CAPACITY.**

●

Install the NIAGARA AERO-PASS CONDENSER and your refrigeration plant operates with a smaller differential between suction pressure and head pressure, gaining for you both an increase in capacity from your compressors and important savings in expense for power.

The New NIAGARA AERO-PASS CONDENSER offers its advantages protected from the danger of loss through shut-downs and maintenance troubles. The 10-year record of Niagara Condensers for dependable full capacity operation is unequalled.

Write, today, for the details of construction, operation and power and water savings. Ask for Condenser Bulletin 101 -HV.

**NIAGARA BLOWER COMPANY**

*Over 30 Years of Service in Industrial Air Engineering*

405 Lexington Ave. New York 17, N. Y.

*Field Engineering Offices in Principal Cities*

# NIAGARA * AERO-PASS CONDENSER

*Trade-mark Registered for the Niagara Condenser with the patented Duo-Pass, Oilout and Balanced Wet Bulb Control.

PEERLESS PUMPS

**Looking for New PROFITS?**

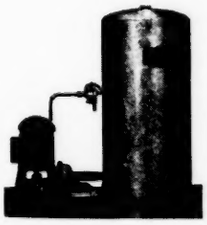
PEERLESS PUMPS

***Peerless* has 2 most advanced DOMESTIC WATER SYSTEMS**

*that will help you capture your share of the Billion Dollar*

**DOMESTIC WATER SYSTEMS MARKET!**

Supported by Effective, Active National Advertising and Marketing Plans



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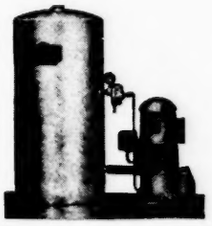
PEERLESS PUMPS



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For Deep or Shallow Wells. Capacities: 400 to 5,000 gals. per hour. Fully Automatic.

**PEERLESS WATER KING**
For Shallow Wells. Capacities: 275 to 840 gals. per hour. Uses an unique pumping principle.

**PEERLESS PUMP DIVISION**
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**PIPE and TUBE BENDING**
**WELDING FABRICATION**

Many foremost manufacturers, having discovered our specialized skill in our particular line, have entrusted us with a great variety of precision pipe and tube work, including bending, coiling, expanding, flattening, brazing and welding.

Swan engineers and technicians, dealing continually with piping, can advise on your bending requirements and offer valuable suggestions on design and economical methods of installation. We invite your inquiries.

**SWAN ENGINEERING CO., Inc.**
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tributed stocks of parts and equipment to serve users and refrigeration engineers with a minimum of delay. Frequently, parts were supplied by one wholesaler to another to meet emergency requirements.

Continued in peacetime operation, a system of strategically located warehouses have supplied parts for emergency repairs in food preservation and air conditioning equipment, as well as the 200 other odd services now performed by mechanical refrigeration.

• **CHANNELS.**—Industry authorities believe that the improved distribution methods will result in speedier and more efficient filling of the demand for air conditioning equipment and further believe that during the inevitable expansion of the air conditioning industry in commercial and industrial fields, through ready-made distribution channels, much of the pioneering usually encountered in a new industry will be eliminated.

## MILWAUKEE ENGINEERS

**move into new headquarters in remodeled Pabst Residence.**

The Engineers' Society of Milwaukee celebrated the opening of their new headquarters with a week of activities climaxed by a banquet at the Municipal Auditorium with Dr. Charles F. Kettering, vice-president in charge of Research for General Motors Corporation, as highlight speaker.

• **REMODELED.**—In 1944 the ESM purchased the elegant old home at 3112 W. Highland Boulevard, built by Frederick Pabst of brewery fame. A campaign throughout industry of the area raised a fund of $100,000 for remodeling and equipping the building. Architectural style of the structure has been retained, while the interior has been remodeled to include indirect lighting, acoustical ceilings, and the most modern and complete facilities available to engineers in the Middle West. Three small auditoriums, each with a seating capacity of about 100 people and so arranged that two of them may be opened to the same program by means of a sliding wall, have been included with other features such as a library, reading and recreation rooms, offices, kitchen, dining rooms, and other facilities.

Officers of the Engineers' Society of Milwaukee, left to right: Henry Oman, secretary; Ernest Szekely, vice-president; J. A. Potts, president; E. L. Knebes, past president; L. T. Rosenberg, treasurer.

• **SOCIETY.**—Founded in 1904, the ESM has grown to a membership of 1366 engineers of the Milwaukee area, embracing all fields of engineering practice. Exchange of ideas for member groups is facilitated by discussions and symposiums on civil or technical topics. Among affiliated groups are: AIEE, ASME, ASCE, ASRE, ASHVE, IRE, and IES.

## REFRIGERATION MANUFACTURERS

**are asked to combat CPA directive said to jeopardize continued production.**

H. F. Spoehrer, president of the Refrigeration Equipment Manufacturers Association, made the charge in Chicago last month that the Civilian Production Administration order diverting all pig iron and iron castings to specified housing components, may force a shutdown of the entire mechanical refrigeration industry.

• **DIRECTIVE.**—Production of some manufacturers has been stopped almost entirely and in other cases slowed as much as 50% by CPA Directive 13 as amended to Order M-21, which restricts the use of pig iron and iron castings to manufacturers of bath-tubs, soil pipe and other products for veterans' homes, Mr. Spoehrer pointed out. This restriction has the effect of channeling essential materials away from refrigeration equipment manufacturers, and without these vital materials, "Our industry cannot produce even domestic refrigerators," he continued.

• **ACTION.**—In an effort to gain modification of the order, Mr. Spoehrer sent a wire to the 100 members of the Association and to other leading associations of the industry which read: "CPA Directive 13 to Order M-21 restricts the use of pig iron for soil pipe, bathtubs, etc., for housing. This directive, if allowed to stand, will result in shutdowns in all industries using gray iron or malleable castings. Condensing unit manufacturers, valve and fitting producers, motor manufacturers and others will be compelled to shut down, thus affecting our entire industry. We urge you to contact by telegram or telephone your senators and congressmen requesting removal of this restrictive directive. Action must be immediate."

Coincident with this appeal, Mr. Spoehrer issued a statement pointing out that, while his industry is in full accord with the Government's aims to promote construction of housing for veterans, the refrigeration industry has always been deemed part of the building industry and during the war was placed high on the priority list of essential industries.

# PREHEAT FOR PROPER HEAT

# WHITLOCK FUEL OIL HEATERS

The Whitlock Type V-1 Oil Heater shown above is of a simple standard design at moderate cost. These units in all-welded construction, adapted to high working pressures, are *immediately available from stock.*

Whitlock Fuel Oil Heaters of more elaborate design are made to suit individual operating conditions and engineered for any combinations of temperature rise, operating pressure and capacity. Incorporating Whitlock's experience of many years in the fabricating of such equipment, they guarantee a unit to suit your requirements for economy and efficiency.

Our engineers will gladly discuss your fuel oil heating problems and make specific recommendations. Write for new Bulletin No. 35 describing and illustrating the complete line of Whitlock Fuel Oil Heaters.

**The WHITLOCK MANUFACTURING COMPANY**

**40 South Street, Elmwood, Hartford 1, Conn.**

NEW YORK BOSTON CHICAGO PHILADELPHIA DETROIT RICHMOND

*Authorized representatives in other principal cities.*
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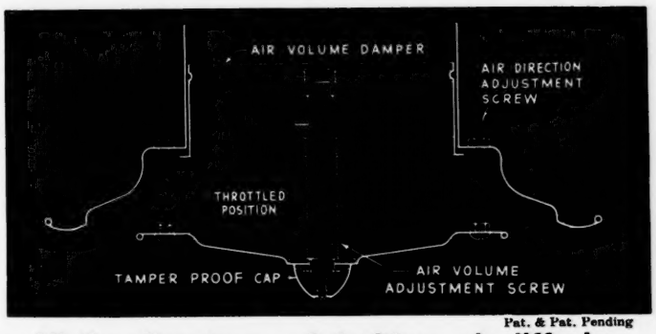


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## All the advantages of draftless air diffusion . . . *plus* FAST SYSTEM BALANCING AIR PATTERN CONTROL

### *because Kno-Draft Air Diffusers are adjustable*

**Volume Damper** for fast system balancing regulates the air outlet aperture uniformly without affecting the outlet velocity or diffusion pattern.

**Air Direction Adjustment** affords any angle of air discharge from vertical to horizontal to accommodate ceiling height, individual, seasonal, or air pattern requirements.

Specify Kno-Draft Diffusers for better mixing control of room and supply air, more uniform temperatures throughout the occupied zone and noiseless, draftless air distribution.

Send for FREE handbook containing sketches, charts, dimension prints and instructive text that simplify the selection and installation of air diffusers. For your copy, please write Dept. E3 using your company letterhead.

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Conseco 15 ton freon heat exchanger, Strand Theatre, N. Y.

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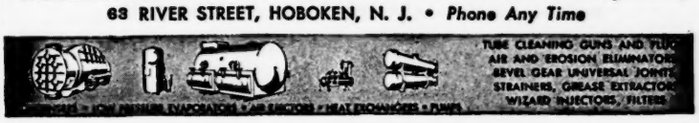
*Let our engineering department help you with your problem.*

We design and manufacture heat exchangers for Freon and other refrigerants for refrigeration and air conditioning services. Quick deliveries. Materials available. We recently designed and built eight large Freon condensers in five days. On an urgent West Coast order we designed and built a unit in three days. Two units were built over a weekend for an emergency. Standard units in stock. For quick, economical service, write, wire or phone.

**CONDENSER SERVICE & ENGINEERING CO., INC.**

63 RIVER STREET, HOBOKEN, N. J. • *Phone Any Time*



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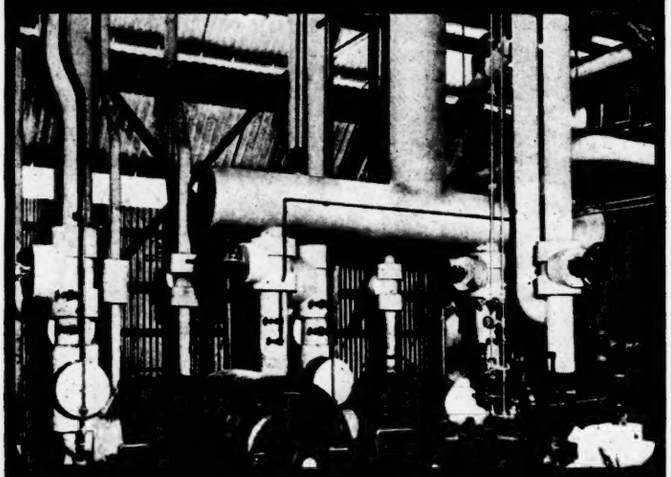

FOR ALL LAGGING WORK

Arabol Lagging Adhesive—designed specifically to hold non-conducting material around pipes, ducts, boilers—is now on the market. This adhesive is easy to apply; eliminates the time-consuming task of sewing. It dries in 4 to 6 hours, leaving a sized finish. Use it on canvas, asbestos, fiberglas or cork. Its finish need not be painted at all, unless you prefer one coat for appearance. Maintenance is simplified—grease, oil, soot and dirt wash off easily. In addition, this lagging adhesive is vermin-proof... fire-retardant, too.

You can depend on Arabol for a thorough job of adhesion. Rigorous tests by independent laboratories proved its adhesive strength despite exposure to extreme temperatures, immersion in water, and steam.

Write us today for the facts and case records. For utility and appearance, don't place open specifications on lagging work—ask for Arabol Lagging Adhesive.

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*Adhesives?...* ARABOL!

## UTILITY UNIT

**displayed to public in 12 model houses in Kalamazoo unites functions in compact central core.**

The Ingersoll utility unit consolidating all essential home utilities in a single, portable, central core (H&V:2:46:p94) will be on display in 12 demonstration houses designed and built by Ingersoll Steel Division, Borg-Warner Corp. of Kalamazoo, Mich.

• **MASS PRODUCTION.**—With dies and jigs in a factory, all the plumbing, pipe lines, electrical wiring, heating, hot water and lighting elements are shaped, fitted and put into a steel framework on an assembly line. This steel framework is the central core of the unit for which Ingersoll supplies appliances for kitchen, laundry, and bath. The central core forms a wall between various parts of each of the 12 houses, especially designed to accommodate its dimensions. The unit is 30 in. wide and can be rolled in through the front door of a house during any stage of construction. It is 77 in. high and 90 in. long.

• **HOUSES.**—The houses shown at Kalamazoo were designed by prominent architects to demonstrate flexibility of the unit in a variety of designs. Houses used in the demonstration are furnished and in some cases occupied by tenants.

Each house has the Ingersoll unit located on its ground floor where it rests upon a specially designed template through which the various utilities have been previously connected. Only one house in the group has a basement and in this house also the unit is located on the main living floor while heat is forced down to the basement through a duct. The other houses are on concrete slabs built to floor level. Flooring is in some cases laid directly on the slab, and in others raised above it by an air space. All the slabs are insulated from the foundation walls.

• **RESEARCH.**—Two of the houses will be retained by Ingersoll for further experiments. One is a solar house designed by George Fred Keck, a single story with two bedrooms. This is designed to combine solar and radiant heating employing new controls for sudden overheating.

The other house retained by Ingersoll is L. Morgan Yost's prairie type modern. This is an arrangement employing an axial hall which serves a dual function as hallway and living space throughout its length from front entrance to two bedrooms and bath at the rear. This is the only house that gives external evidence of the Ingersoll unit in the form of a flat deck directly over the core protecting its ventilation.

### Supply Note

A new CPA order (PR33, Schedules A and B, Directions 1 and 1-A) states that 75% of convector and cast iron radiation, by square feet of heating surface or producer's billing price for convectors without inclosures, and 75% of warm air furnaces, by producer's billing price, must be physically set aside by dealers and reserved indefinitely to honor HH and other priority ratings. Other materials covered by that order must be set aside in proportions up to 95%.

# How to STEP UP
## air conditioning efficiency

**Dorex Air Recovery Units increase plant capacity without increasing conditioning equipment, automatically control odors, and save power and fuel.**

A great percentage of the heated, cooled, humidified and cleaned air that is ordinarily exhausted because it is stuffy, odorous or stale can be economically restored to original freshness and recirculated. This reduces the load on heating, refrigerating and humidifying equipment, lowers operating cost and expands the capacity of the system.

**Nothing is added to the air. The specially processed activated carbon used in Dorex Air Recovery Equipment extracts all odorous impurities that originate from people and their habits, from tobacco smoke, food and liquor, oils and solvents. Obviously, when you remove these impurities from the indoor air, less outdoor ventilation air is needed, which materially reduces the conditioning load.**

**PROOF:** We will be glad to send the details of typical installations or estimate on planned or existing systems. Write Dept. E-5, or call our District Representative.

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POWERS TEMPERATURE and HUMIDITY CONTROL

**When you want accurate and dependable automatic temperature or humidity control for Heating, Ventilating and Air Conditioning Systems or Industrial Processes call in a Powers engineer. With a very complete line of self-operating and compressed air operated controls we are well equipped to fill your requirements.**

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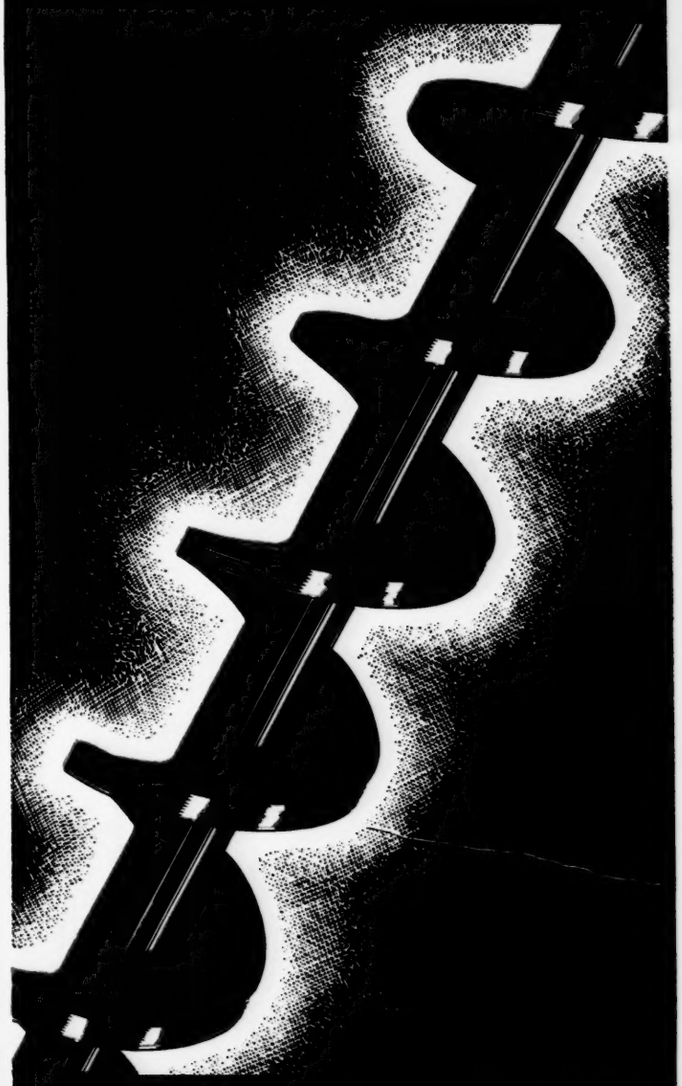
## PITCHES AND SIZES



_____ is an extremely versatile material. Not only is it tough and wear resisting, but it is capable of being readily shaped into an infinite variety of sizes and pitches, tapered or constant diameter, right hand or left hand. That's why so many stoker manufacturers use the Crown wrought steel stoker feed screw. They know that Crown can produce a tough, continuously welded wrought steel screw to meet their most exacting specifications.

*Send specifications and drawings for price.*

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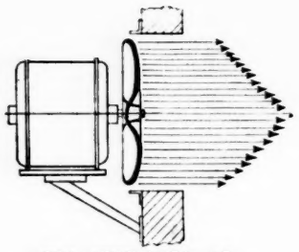
## IRON WORKS COMPANY

**1229 Tyler Street N.E. Minneapolis 13, Minn.**

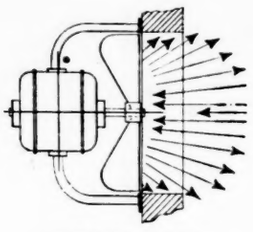
# STILPHEN "Stil-Blade"

*Exhaust Fans*

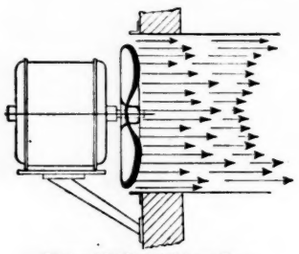
***Proved by Years of Performance***



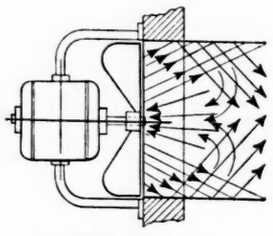
Stilphen "Stil-Blade" Exhaust Fan—without duct work



Steel Blade Exhaust Fan—without duct work



Stilphen "Stil-Blade" Exhaust Fan—with duct work



Steel Blade Exhaust Fan—with duct work

## Results of Impartial Performance Tests

Outstanding efficiency of Stilphen "Stil-Blade" Exhaust Fans is due to special design of fan wheel which has reverse curve at back edge of blade insuring quiet operation, minimizing air friction and eddy currents. Wheel is cast of aluminum alloy in one piece, eliminating chance of blades working loose and throwing fan wheel out of balance.

Write for information. Howry-Berg Steel & Iron Works, 2949 N. Speer Blvd., Denver 11, Colo.

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## NEW CATALOGS

### Blowers, Compressors, Pumps

The A-B-C of Allis-Chalmers turbo-blowers, rotary compressors and vacuum pumps is explained fully in a 16-page booklet designed for student training which tells what these units are, how they operate and how to figure them. The booklet shows the simple construction of the Allis-Chalmers turbo-blower and tells why it is important that complete information be furnished to figure blowers correctly. Reproduced are curves depicting pressure volume, influence of water vapor on volume and correction curves for volumes to maintain constant air weight with changes in temperature and barometric pressure.—*Allis-Chalmers Mfg. Co., 677, Milwaukee 1, Wis.* ..... **106**

### Precision Brakes

Announcement of a redesigned Di-Acro brake for die-less duplicating of small metal parts is made in a new 4-page folder describing 10 new features of this universal metal forming machine.—*O'Neil-Irwin Mfg. Co., Minneapolis 15, Minn.* ..... **107**

### Pipe Conduit

A new bulletin entitled "Therm-O-Tile, The Permanent Conduit for Underground Pipe Lines," 4 pages in two colors, describes Therm-O-Tile applications, construction and specifications.—*H. W. Porter & Co., 825 Frelinghuysen Ave., Newark, N. J.* ..... **108**

### Compressors

Two new bulletins describe Worthington compressors. Bulletin L-680-B1A, 32 pages in two colors, describes and illustrates opposed steam driven compressors. A series of applications is illustrated and construction features are detailed including the Worthington Feather valve. Cutaway drawings illustrate construction and operation features. Bulletin L-640-B1A, 24 pages in two colors, describes single horizontal compressors. — *Worthington Pump and Machinery Corp., Harrison, New Jersey.* ..... **109**

### Liquid Filters

Staynew liquid filters for oils, water, chemicals, etc., in a wide range of models and sizes are described in a new 8-page catalog.—*Dollinger Corp., 11 Centre Park, Rochester 3, N. Y.* ..... **110**

### Pipe Bender

A new 8-page bulletin No. A-7, dealing with a portable hydraulic pipe bender, describes and illustrates details of construction, capacity, and operation techniques. A chart of radii of bends to center line pipes is included. This bender will bend all standard, heavy, and extra heavy double steel pipes in sizes ⅜ in. to 2 in., inclusive.—*Watson-Stillman Distributor Products Div., Roselle, New Jersey.* ..... **111**

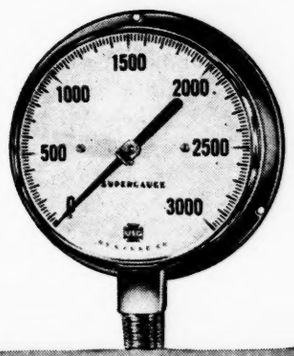
MARLEY

THE MARK OF SUPERIORITY

. . . in design, construction
and operational excellence

MARLEY COOLING TOWERS

THE MARLEY COMPANY, INC. • KANSAS CITY 15, KANSAS

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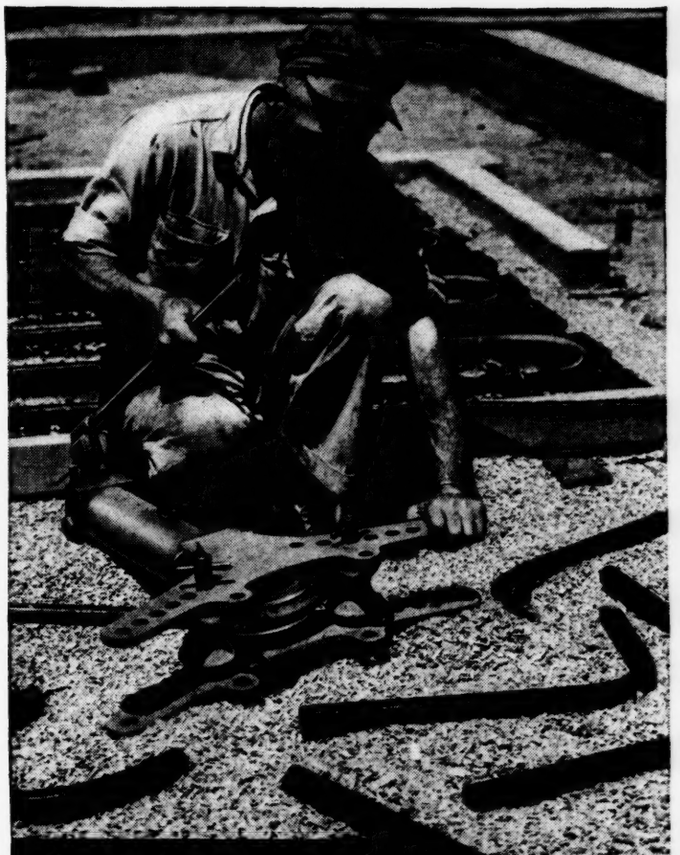

For radiant heating

Tal Announces
Another Major Engineering First
180° Bends In One
Lightning Operation

Now, with this 180° portable bender, you can thumb your nose at your problems of getting fittings and hiring good welders . . . . for with this carry-to-the-job machine, you can bend any wrought iron or steel pipe 3/8" to 3" in one fast moving operation. You reduce the need for welds and fittings 40 to 80%; do in minutes, work that required hours of time before.

Quality engineering has made Tal the bender preferred by hundreds of heating and plumbing contractors everywhere who have already swung to this new way of handling pipe by lightning bending. Use it for radiant heating installations — *and for all other plumbing and heating work too.* Write today for factual data bulletin on this great time saving, money-making tool.

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Tal Prestal Bender, Inc.

Dept. HV-10, 417 No. Water St., Milwaukee 2, Wis.

A *Good Investment* IN "AIR CONDITIONING DEPENDABILITY"...

A-P DEPENDABLE REFRIGERATION VALVES

MODEL 70-NA

Solenoid Refrigerant Valve. Compact, rugged, leakproof — high capacity, up to 20 tons Freon — requires little power.

When you install A-P Dependable Refrigeration Valves on your best air conditioning systems you're getting factory-proven, field-proven valves that most engineers know will aid them to peak operating efficiency. A-P Thermostatic Expansion Valves are famous for their extreme sensitivity and close superheat control, even under wide variations in load. And A-P Solenoids are versatile, quick-acting, require minimum power, and can be depended on for long trouble-free service . . . And the same over-all *dependability* is built into all the other vital A-P Refrigeration Valves — Suction Pressure Regulating Valves, Water Regulating Valves, "Trap-Dri" and "Trap-It" System-Protectors, Water Solenoids and Cooling Thermostats.

Your Best Systems Deserve A-P DEPENDABLE REFRIGERATION VALVES.

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A-P DEPENDABLE *Refrigerant Valves*

FOR AIR CONDITIONING • REFRIGERATION • HEATING

### Pipe Fittings Chart

A new chart of pipe and fitting materials, 9 x 14 in., folded to fit a standard notebook, deals with carbon, intermediate alloys, stainless and special analysis steels, and covers ASTM specifications, chemistry, service limitations, and welding procedure.—*Tube Turns, Inc., Louisville, Ky.*....112

### Testing Facilities

Facilities for testing heating, ventilating and air conditioning equipment covering heat transfer apparatus, valve, boiler and air filter testing equipment available to industry for impartial, professional testing and rating are described in a new four page folder. —*United States Testing Company, Inc., Hoboken, New Jersey.*....113

### Condenser Tubes

"Condenser Tubes" is the title of a new brochure including several tables designed to help users of condenser tubes select most efficient materials for their operating equipment. It shows a graph giving safe working pressures and has two pages devoted to estimating data covering tube sizes from 5/8 in. to 2 in. O.D.—*Wolverine Tube Division, Calumet and Hecla Consolidated Copper Co., 1411 Central Ave., Detroit 9, Mich*....114

### Time Switches

A four page bulletin, T155, describes special-built time switches for volume users. These time controls are designed for machine and process equipment makers and are said to meet strict requirements for ruggedness, flexibility and accuracy. The line described in this bulletin consists of low-cost time switches for the special needs of original equipment manufacturers.—*Automatic Temperature Control Co., Inc., 54 E. Logan St., Philadelphia 44, Pa*....115

### Fin Coil Data

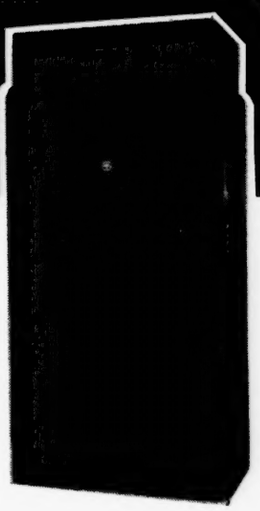
Tables of refrigeration data and engineering information are contained in the new illustrated catalog, No. 120, on fin coils and custom built air conditioning units for low temperature cooling. Specific information as to length of case, fin space, number of coils required, overall dimensions, surface in square feet, etc., are included.—*Rempe Company, 340 N. Sacramento Blvd., Chicago 12, Ill.*....116

### Vertical Motors

Protected-type motors designed for close coupling of centrifugal pumps, agitators, atomizers and many types of machine tools are described in a new bulletin SL-300-3. Drawings and dimensions of the NEMA "C" face mountings are shown in frame sizes up to and including 326. Among the features described in this new bulletin are a recessed junction box, dynamically balanced *Alucast* rotor, and coils protected by *Vinylastic* insulation.—*Crocker-Wheeler Electric Mfg. Co., Ampere, N. J.*....117

# TYPHOON

A RESPECTED NAME IN AIR CONDITIONING



**3 and 5 TON SELF-CONTAINED UNITS**

All-purpose, handsomely designed, smooth functioning air conditioning units with all copper condenser and liberally designed coils—removable outlet box for use with duct system—removable panel in back of outlet box for additional grills where front and back air distribution is desired in center of room . . . two way adjustable deflecting grill . . . knock-out for fresh air connection . . . removable one-piece panel in front for easy accessibility. The cabinets are made of furniture steel . . . crackle finish. **Also available with one or two row heating coil.**

**TYPHOON PRODUCTS**

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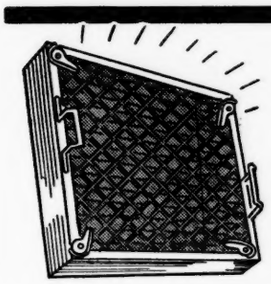
ICE AIR CONDITIONING CO., INC.

794-6 UNION STREET · BROOKLYN 15, N. Y.



# Easier Way to Clean Air Filters

Efficiency of air conditioning units is largely dependent on periodic cleaning of air filters . . . regular, complete removal of deposits entrapped from the air is necessary to maintain high filtering capacity.

If your filters are of the dry or viscous impingement washable type, you can clean them easily and effectively by using Oakite materials specially designed for this work. Dirt, dust, soot, lint, pollen and other foreign matter collected on surfaces are thoroughly removed . . . full filtering capacity is quickly restored . . . equipment out-of-service time is reduced to a minimum.

Dependable Oakite materials and techniques are available for expediting other essential air conditioning maintenance jobs. Write us concerning your problems. There's no obligation.

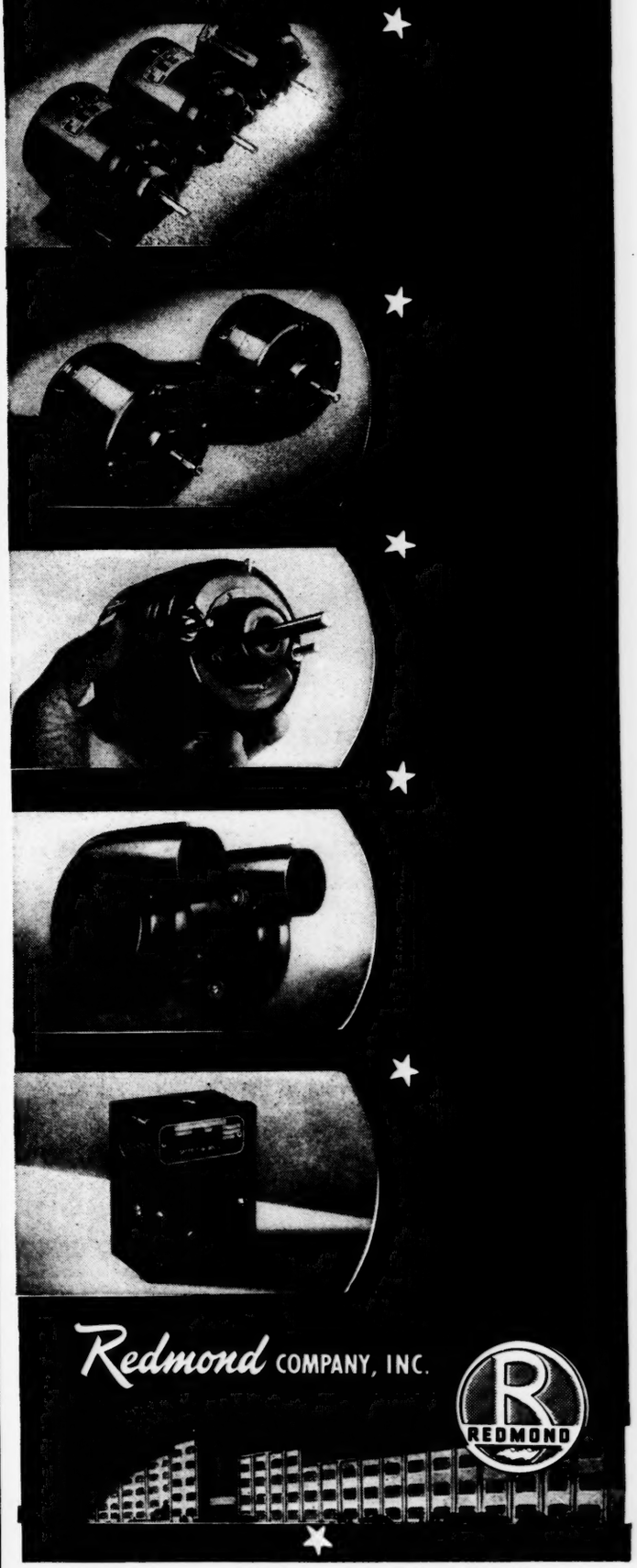
**OAKITE PRODUCTS, INC., 58A Thames St., NEW YORK 6, N. Y.**

*Technical Service Representatives Conveniently Located in All Principal Cities of the United States and Canada*

**OAKITE** *Specialized* **CLEANING**

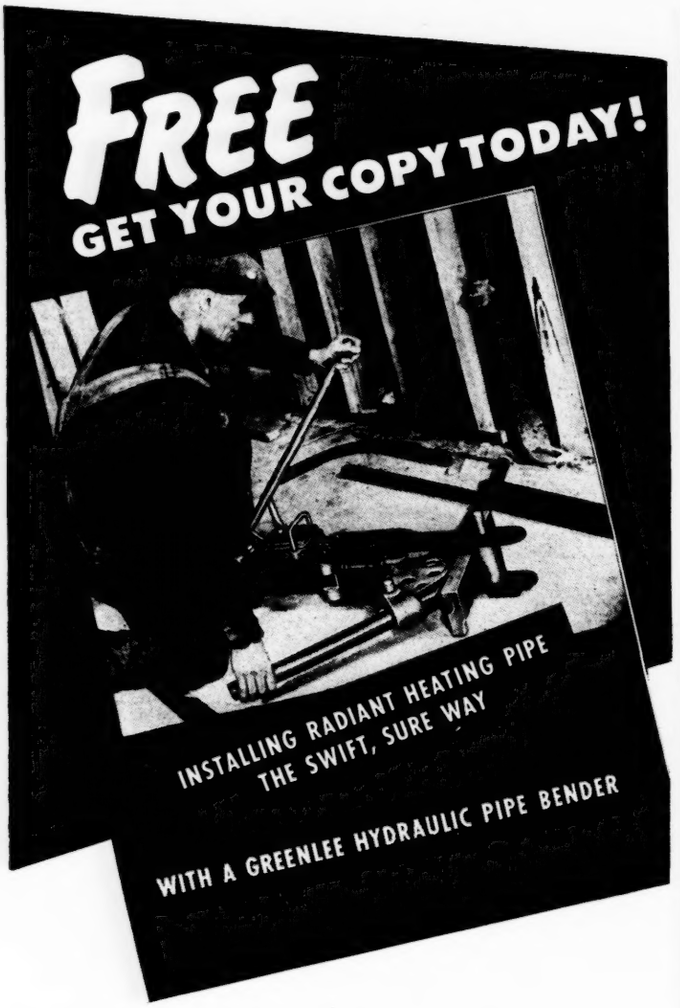
MATERIALS · METHODS · SERVICE · FOR EVERY CLEANING REQUIREMENT

# Redmond



Redmond COMPANY, INC.

REDMOND




**INFORMATIVE CASE STUDY OF RADIANT HEATING PIPE INSTALLATION**

● The Radiant Heating Era is here! And whether you are planning radiant heating installations now or are getting set to make them during the big building days at hand, you will want to see this new, pictorial Case Study of a recent radiant heating job.

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### Process Control

Bulletin 381 describes the Model 40 controller, the newest addition to the Foxboro line of instruments for process control. Indicating models of single or multiple pen recorders are shown and the five types of control action available in the Model 40 are explained.—*The Foxboro Co., Foxboro, Mass.* ....118

### Welding Electrodes

A 64-page catalog of welding electrodes and oxy-acetylene gas welding rods gives complete descriptions, color indentifications, specifications, physical properties, welding procedures, etc. There are tables on the weldability of metals, estimating charts, etc.—*Hollup Corp., 4700 W. 19th St., Chicago 50, Ill.* ....119

### Condensate Return System

Publication No. 3250 describes the Cochrane C-B condensate return system, which employs a specially designed centrifugal pump to energize an eductor which in turn pumps the condensate from engine drainage return lines directly into the boiler against boiler pressure.—*Cochrane Corporation, Philadelphia 32, Pa.*....120

### Plumbing and Heating

Plumbing and heating equipment for low cost homes is featured in a new 20-page booklet. Items include bathroom and kitchen fixtures, water heaters, and boilers for space heating. — *Crane Co., 836 S. Michigan Ave., Chicago 5, Ill.* ....121

### High Pressure Pumps

Catalog D-446 covers type ES small, high pressure pumps for pressures up to 200 lb per sq inch. This catalog is a 4-page folder giving dimensions and performance charts of this high pressure series of pumps. —*Economy Pumps, Inc., Hamilton, Ohio.* ....122

### Motors

A variety of electric motors, ranging from 1/80 to 15 horsepower at speeds up to 10,000 rpm and voltages from 6 to 600 volts, is described in an eight page bulletin, Catalog 46-1.—*Electric Specialty Co., Stamford, Conn.* ....123

### Self-Fluxing Solder

A 4-page folder describes Tri-Core, a self-fluxing solder with three cores, said to eliminate empty flux sections and permit use of lower tin content solders.—*Alpha Metals, Inc., 359 Hudson Ave., Brooklyn 1, New York.* ....124

### Dust Collector

A new Aerotec bulletin No. 310, on an integral dust collector specifically applicable to the grinding and buffing industry, describes a packaged collector complete with motor and fan, in ratings of from 300 to 2100 cfm. — *Thermix Engineering Co., Greenwich, Conn.* ....125

### Tube End Forming

A 4-page bulletin No. G-1, describes a complete line of tube end forming equipment. Emphasis is placed on the versatility of the machinery through illustrations of many tube end shapes.—*Vaill Engineering Co., 17 Brown St., Waterbury 89, Conn.* .....126

### Water Level Control

Bulletin 459 describes the installation of water level controls at Wyman-Gordon Co. Charts illustrate relation of steam output to water level fluctuation controlled by Copes Flowmatic regulators. — *Northern Equipment Co., Erie, Pa.* .....127

### Hose

Catalog sections on suction hose for excavating and general utility services and various brands of industrial water hose are available on request.—*B. F. Goodrich Co., Akron, Ohio.* .....128

### Diesel Engine

Bulletin S-500-B42A, 36 pages, describes the Worthington DH Diesel engine, which is produced in seven types in combinations of 5, 6, 7 and 8 cylinders. The bulletin describes and illustrates with cross-sectional drawings in color the operation, control systems, and construction details of the various types of Diesel engines.—*Worthington Pump and Machinery Corp., Harrison, New Jersey.* .....129

### Oil Heaters

A 12-page catalog in two colors gives data on the construction and design of Wa-Tu-Bo oil heaters. These heaters, made in both straight tube and U-tube types, are used for preheating oil in the fuel room or in large storage tanks.—*Water Tube Boiler and Tank Co., Inc., 140 W. Root St., Chicago, Ill.* .....130

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OCTOBER, 1946

**TO OBTAIN COPIES OF TRADE LITERATURE listed in this issue, circle on the list below the publications wanted, using the item number at the end of each review.**

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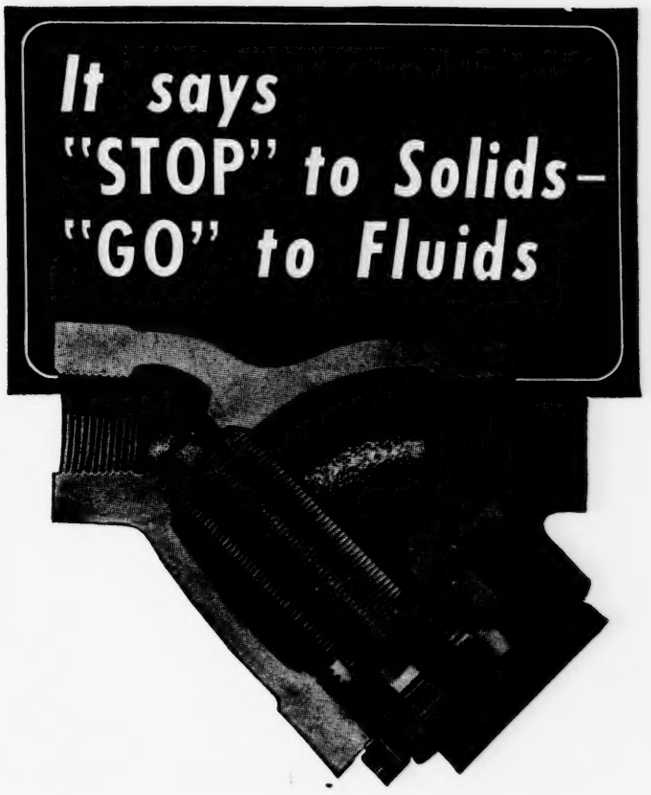


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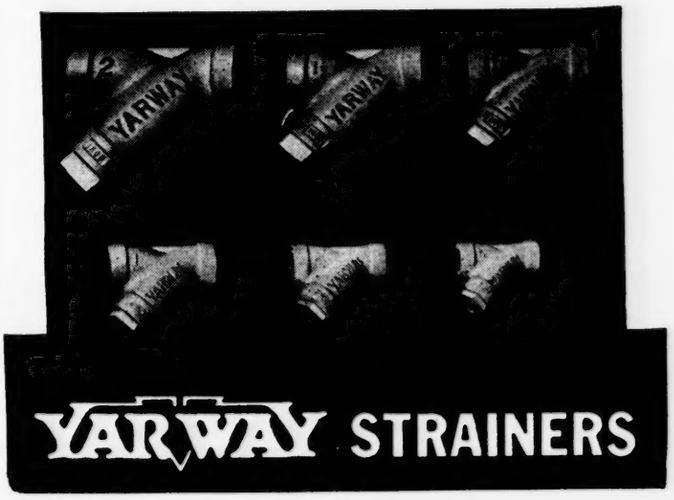

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**BLAST HEATING COILS—AIR CONDITIONING COILS—ALL TYPES**

All copper spiral fin tube construction with the tubes formed or bent permits uniform expansion without strain. Headers are heavy wall construction with tubes brazed into extended ferrules formed in the headers. Fins are helically wound and metallically bonded. May we send catalog?

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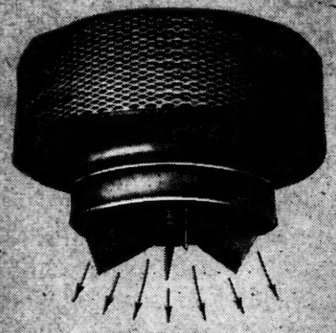

A proven heating unit, modern in design, incorporating every unit heater advancement. McCord copper spiral fin tube construction creates air turbulence without undue restriction. Improved fan blades deliver large volume of air with minimum air noise. Guaranteed for 150 lbs. saturated steam pressure. Specify McCord.

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A time proven heating unit, modern streamlined in design, quiet, yet its rugged construction adapts it to all types of installations, guaranteed for use on No. 150 p. s. i. steam pressure. All copper heating element, individual spiral fin tubes free to expand without strain on joints. Standard motors with standard bases used. Wide range of capacities.

Save fuel with McCord Unit Heaters.

McCord CORPORATION
DETROIT 11, MICH.


# Getting Personal

*Arthur S. Griswold*

**Arthur S. Griswold** *(Does Night Shutoff of Heating Pay?*, page 65) was born in Connecticut and received his M.E. from Cornell University in 1922. Since that time he has been associated with the Central Heating Department of The Detroit-Edison Company. His activities have concerned the development and operation of the company's heating plants, engineering and utilization work with the company's steam customers, and consulting work involving steam problems of the company's electric power customers.

For three years during the war he was associated with the Office of War Utilities of the War Production Board in Washington, D. C.

Griswold is a Michigan registered professional engineer, member of the Engineering Society of Detroit, the National District Heating Association, and the American Society of Heating and Ventilating Engineers.

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# . . . Since the Last Issue

Production of air conditioning and industrial refrigeration equipment during the next 12 months at the Hyde Park plant of the **B. F. Sturtevant Co. Division of Westinghouse Electric** is expected to more than double the quantity built during the best pre-war years, according to G. C. Derry, vice-president and general manager of the Division. At the same time he revealed plans for stepping up manufacture of mechanical draft fans for power stations and fans for industrial plants in the coming years. Expansion in these two fields, as well as in the rapidly growing transportation field and in many others concerned with air handling, should ultimately increase the Division's production force by 50% and the sales and engineering staff by 30%. The Division's current backlog of orders totals approximately $14,000,000.

Appointment of **Thomas E. Jervis** as comptroller of **Carrier Corp.** has been announced by Cloud Wampler, President. Mr. Jervis, during the war, served as comptroller of the Woodridge Plant of the Wright Aeronautical Corporation. Prior to that he was connected with Lybrand, Ross Brothers and Montgomery, public accountants. He is a graduate of the University of Illinois, a certified public accountant, and a member of the Controllers Institute of America and the American Institute of Accountants.

*T. E. Jervis*

Appointment of **Arthur P. Shanklin** as vice president and general sales manager of **Carrier Corp.** is announced by Edward T. Murphy, senior vice president. Effective November 1, 1946, Mr. Shanklin will be in charge of all of Carrier's domestic sales activities. A vice president of Carrier Corp. since 1941, Mr. Shanklin has been associated with the company since his graduation from the University of Kentucky in 1922. During this period he has served in many sales and executive capacities and at present is vice president in charge of dealer sales.

**The Bryant Heater Co.**, Cleveland, announces the appointment of **Malcolm McLean** and **Raymond A. Bissell** as district representative of the company in the New York area. Working with M. H. Laundon, Jr., Bryant branch manager, the two men will extend Bryant's services in the area in the application of the company's varied line of gas-fired heating equipment. D. A. Campbell, manager of Bryant's Industrial Division, announces the appointment of **Homer A. Size** and **Arthur X. Nelson** as representatives of the division in the application of Bryant gas combustion elements to industrial and process heating equipment. Mr. Size will represent the division in California and Mr. Nelson, operating Plant Equipment, Inc., will serve the Minneapolis area.

*H. A. Size*

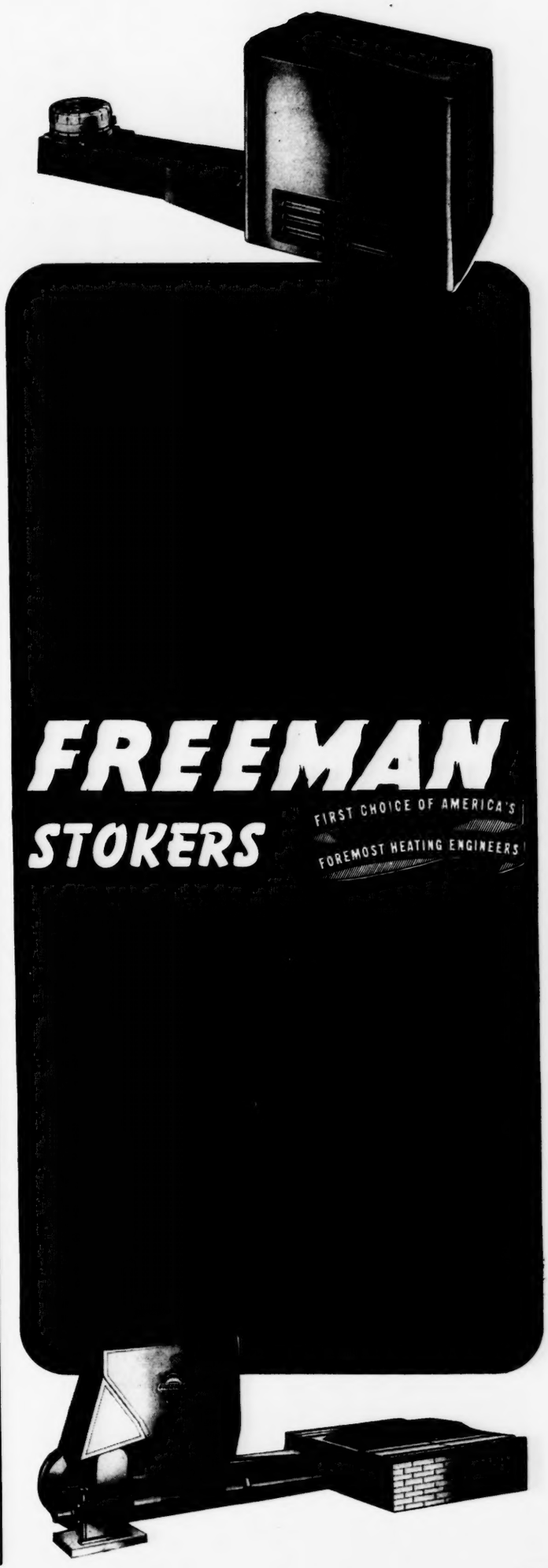
Third Annual Meeting of the **Indoor Climate Institute**, non-profit service organization of the heating industry, was held in Detroit, September 12, 1946. The following officers were elected for the ensuing year: President, **T. A. Crawford**, general manager, Timken Silent Automatic Division, The Timken-Detroit Axle Company, Detroit, Mich.; vice-president, **J. M. McClintock**, manager, Freeman Stoker Division, Illinois Iron & Bolt Co., Chicago, Ill.; secretary, **R. E. Moore**, vice-president, Bell & Gossett Co., Morton Grove, Ill.; treasurer, **E. N. McDonnell**, president, McDonnell & Miller, Inc., Chicago, Ill.

**The Anthracite Institute** has completed the transfer of all its equipment from Primos, near Philadelphia, to the new headquarters of the institute in Wilkes Barre, Pa., and work has been resumed on numerous projects interrupted by the move. In reviewing the laboratory's activities since it was established 16 years ago, Dr. Johnson reported that it has made more than 900 different investigations on all phases of basic and applied research concerning anthracite and in testing equipment. These include 163 stoker investigations, 129 on controls, 61 on boilers, 28 on furnaces, 38 on space heaters and many others ranging from kitchen ranges to fireplaces.

Announcement is made by **Oakite Products, Inc.**, New York, of the appointment of **J. C. Leonard** as sales manager of its Industrial Marketing Division. Associated with the Oakite organization in the servicing of its specialized cleaning materials and equipment for over 22 years, the last 16 years of which was in the capacity of Manager of the Company's Chicago Division, Mr. Leonard assumed his new duties on September 1, 1946. He will direct the marketing and servicing activities of Oakite's industrial field staff from the general offices of the company in New York.

*J. C. Leonard*

During the past summer more than 30 new customers, both large and small, have been added to the steam heating service of **The Detroit Edison Co.**, or will be connected during the fall months this year. About 100,000 pounds of steam per hour will be required to heat the buildings involved. Some of the larger of these new customers are: Harper Hospital, 28,000 lb steam per hour and Wayne University, 25,000 lb steam per hour. Both Wayne University and Harper Hospital consist of groups of several buildings, some of which formerly had individual heating plants.



Most anybody looks on a cut-rate diamond deal with suspicion. The bargain usually fails to materialize.

Carry that suspicion into the field of plumbing supplies the next time you are offered merchandise at big discounts. You may be buying a load of trouble.

In fact, the only safe course is to patronize the reputable jobber in your vicinity who makes a specialty of carrying trustworthy merchandise.

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CAST FITTINGS

*"K" fittings are carried in stock at Malleable Iron Fittings Co., Branford, Conn.; M. I. F. stocks at Kuhns Bros. Co., Dayton, Ohio.*


**Fred F. Hoyt,** vice president and treasurer of the **Carrier Corp.,** Syracuse, New York, manufacturer of air conditioning equipment, has been elected a vice president of the **Controllers Institute of America.** This action took place at the fifteenth annual meeting of the Institute, held Sept. 15-18, in the Commodore Hotel, New York. The Institute is a technical and professional organization of controllers, devoted to the improvement of controllership procedure.

**Richard T. Abrell,** recently named eastern sales manager of **Redmond Distributors, Inc.,** has been transferred to the company's eastern office located in the Graybar Building, 420 Lexington Avenue, New York City. Mr. Abrell is a graduate electrical engineer of Purdue University. He served as central district manager of Master Electric Co., Dayton, Ohio, and as assistant to executive vice-president of Ohmer Register Co., Dayton, Ohio. Later he became director of sales of the Ohmer International Corp. During the war Mr. Abrell joined Redmond Co., Inc., Owosso, Mich., where he specialized in government dynamotor contracts and special motors, serving in this capacity until his recent appointment as eastern sales manager of Redmond Distributors, Inc., of New York City.

*R. T. Abrell*

**Murray Kice, Jr.,** Chief Engineer of **American Blower Corp.,** Detroit, Mich., died on September 25th at Harper Hospital after a two-year illness. Prominent in the heating and ventilating industry as a writer of many published articles, he was active in the American Welding Society, Engineering Society of Detroit, Economic Club, ASHVE and ASME. Mr. Kice was born in Louisville, Kentucky, in 1893.

A series of seven supervisory changes including promotions of field and home office personnel of the **Minneapolis-Honeywell Regulator Co.** have been announced by C. B. Sweatt, executive vice-president. **James S. Locke,** who has been Chicago regional sales manager of the company's Air Conditioning Controls Division, has been named sales manager of the division and will transfer his headquarters to Minneapolis. **George D. Guler,** who has been sales manager of the Air Conditioning Controls Division, has been transferred to Atlanta where he will serve as regional manager in that territory. He succeeds **Albert H. Koch** who has been made Philadelphia branch manager. Succeeding Mr. Locke in Chicago will be **J. F. Cummiskey,** while **L. C. Johnson** has been promoted to branch manager in Milwaukee, replacing Harold Pride who has resigned to accept

*J. S. Locke* *T. S. Carley* *G. D. Guler* *A. H. Koch*

a position with a Honeywell distributor. **J. C. Dorsey,** who has been acting branch manager in Philadelphia, has been placed in charge of manufacturers' business in Philadelphia and henceforth will supervise all such activity in the southern part of Honeywell's eastern sales zone. In Minneapolis, **T. S. Carley** has been promoted to sales manager of the Wholesale Division and, in addition, will continue as sales manager of Honeywell's Stoker Controls Division.

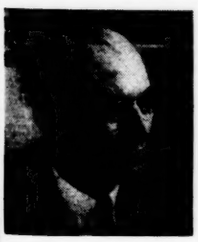
**J. J. Friedler, Jr.**, southern district manager of the **Ilg Electric Ventilating Co.**, has been elected to the board of directors. Mr. Friedler has been associated with the New Orleans office of the company for over twenty years. After graduating from Yale with a B.S. degree in the class of '25, he entered Ilg employ as a salesman in the New Orleans branch office. Simultaneous with this announcement came notice of other changes in the Ilg sales organization from

*J. J. Friedler, Jr.* *G. C. Jelliffe* *K. P. Ribble* *E. B. Bomar*

P. D. Briggs, vice-president and general sales manager. **G. C. Jelliffe**, formerly Lieutenant Commander in the U. S. Navy, has been appointed as direct assistant to Mr. Briggs in the New York office. Prior to his war experience he was Metropolitan Division Manager of Western Union Telegraph Co. in New York City. **Keith P. Ribble** has been placed in charge of the Houston office, one of the Southern offices under Mr. Friedler's direction. Mr. Ribble, a graduate of Georgia Tech, was a long time representative of Allis Chalmers Manufacturing Co. The Phoenix office is now being operated by **E. B. Bomar**, who has been a sales engineer in that area for several years, since attending Oklahoma University and the Texas College of Mines.

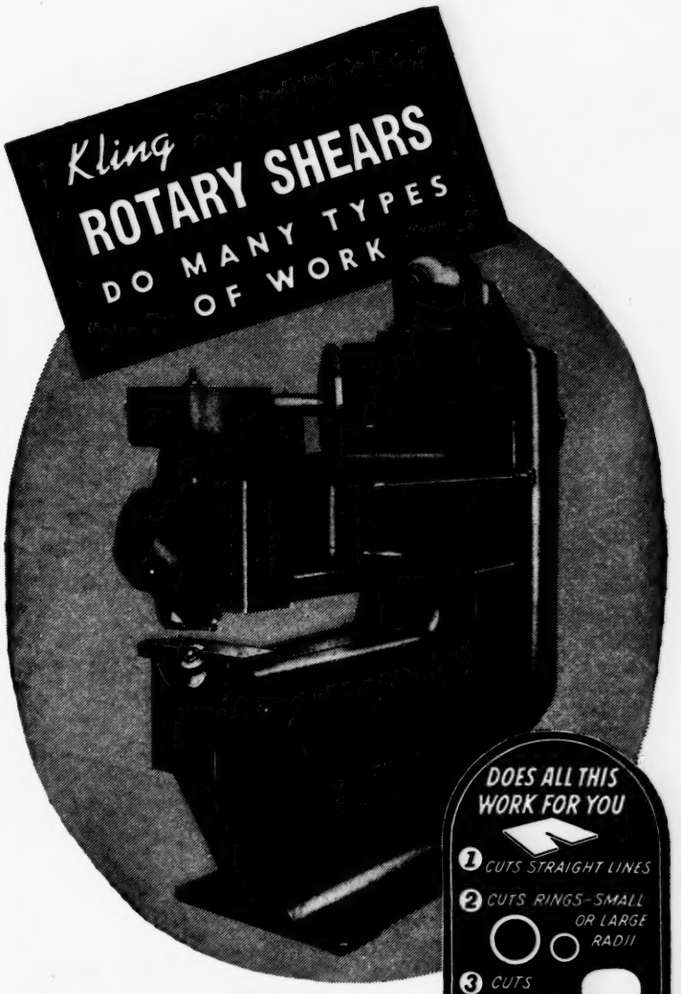
Completion of a correspondence training course in heating salesmanship has been announced by Robert S. Waters, President of the **National Radiator Co.** Preparation and distribution of the course will be accomplished through the cooperation of La Salle Extension University. Writing of the text material was done by the La Salle Staff under the direction of R. L. Swats, President of the University. Cost and promotion of the training course has been underwritten by National Radiator Company and preliminary results indicate wide acceptance in the industry.

**Ralph Redmond** has been appointed treasurer of **Redmond Co., Inc.**, Owosso, Michigan, in addition to his regular duties as vice-president in charge of purchases. Mr. Redmond started with the Redmond Company in 1925 when there were only 18 employes and the company manufactured a gasoline filter. In 1933 when the company entered the field of small fractional horsepower motors, Mr. Redmond became office manager and purchasing agent. The Redmond Company expanded in the motor industry and grew to a total employment in excess of 2000 people. He was appointed vice-president in December, 1944, and is serving in that capacity at present along with his new activities as treasurer.



*Ralph Redmond*

**A. C. DuPerow**, 438 Forestview Road, Bay Village, Ohio, has been appointed as representative for **H. B. Smith** boilers in the Cleveland, Ohio, territory. Mr. DuPerow will handle Smith boilers in northern Ohio.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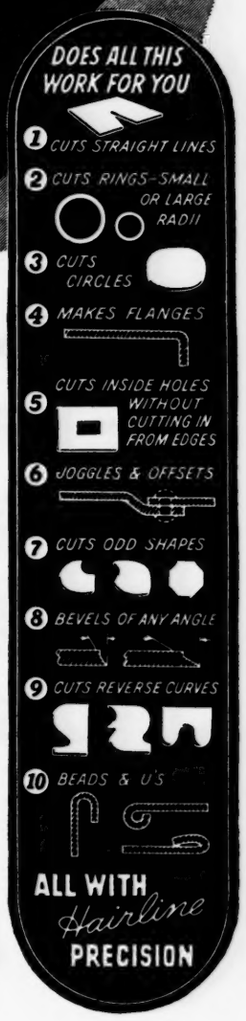
**For exacting projects (see illustration at the right), no single unit of metal-working equipment does so many different things so cleanly and efficiently as does the Kling Rotary, pictured above.**

**In metal working plants, automotive, aviation, home appliance, and other industries, where work of this character is being done, — this machine is held in high regard for its versatility and economy of operation.**

**This great usefulness is the result of half-a-hundred years of engineering experience which prospective buyers, with reason and respect, applaud.**


DOES ALL THIS WORK FOR YOU
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4 MAKES FLANGES
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9 CUTS REVERSE CURVES
10 BEADS & U'S
ALL WITH Hairline PRECISION

*Send Today for* **Bulletin No. 245** which will give you specific facts, and specifications. No obligation involved. Users of heavy equipment of Kling Rotary Shears' class will receive a copy of this Bulletin promptly, on request.

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Units range from 18.4 to 1421 square feet of cooling surface... and capacities range from 2 to 150 tons.

With 100 different sizes within the above dimensions, the buyer of a Patterson-Kelley Cooler for Freon, or Methyl Chloride, can so closely match his requirements including a suitable safety factor that he need not buy excess, unusable capacity.

Such broad service to the air conditioning and refrigeration industries implies **specialization**. And that is just what Patterson-Kelley Engineers have been doing for many years... specializing in Coolers, Condensers, Liquid Line Heat Exchangers and other heat-transfer equipment needed in your industry.

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*Representatives in Principal Cities*

**Marlo Coil Co.** has opened a new sales office at **1519 Connecticut Ave., N.W., Washington, D. C.,** to cover that general area. **H. R. Iverson,** recently released to inactive duty by the Navy as Lt.-Comdr., is in charge and will resume for Marlo his previous long term career in the refrigeration industry interrupted by the war.

**Detroit Lubricator Co.** announces with deepest sorrow the death of **Walter S. Landon,** on August 21st. At the time of his death, Mr. Landon held the position of chief engineer, Oil Burner Controls Division, and had been with the company 23 years. He was recognized by the industry as an outstanding authority on oil burner control design.

## COMING EVENTS

OCTOBER 24-25, 1946 — Joint Fuels Conference of the American Society of Mechanical Engineers and the American Institute of Electrical Engineers, at the Bellevue-Stratford Hotel, Philadelphia, Pa. A. W. Grosvenor, Drexel Institute of Technology, Philadelphia, Pa.

OCT. 28-NOV. 1, 1946—REMA Annual All-Industry Refrigeration and Air Conditioning Show, Cleveland Public Auditorium, Cleveland, Ohio. Refrigeration Equipment Manufacturers Association, 43 East Ohio Street, Chicago 11, Ill.

WEEK OF NOVEMBER 11, 1946—74th Annual Meeting of the American Public Health Association, to be held in Cleveland, Ohio. Further details from Dr. Harold J. Knapp, Health Commissioner, Cleveland, Ohio.

NOVEMBER 17-22, 1946—Annual Meeting, American Welding Society, Hotel Ambassador, Atlantic City, N. J. Office of Secretary, 33 W. 39th St., New York 18, N. Y.

NOVEMBER 18-22, 1946—28th Annual National Metal Congress and Exposition, Municipal Auditorium, Atlantic City, N. J. Secretary, W. H. Eisenman, American Society for Metals, 7301 Euclid Ave., Cleveland, Ohio.

DECEMBER 2-7, 1946—17th National Power Show, Grand Central Palace, New York. Charles F. Roth, manager, International Exposition Co., Grand Central Palace, New York 17, N. Y.

DECEMBER 15-18, 1946 — Annual Meeting of American Society of Refrigerating Engineers, Hotel Pennsylvania, New York, N. Y. Secretary, David L. Fiske, 40 W. 40th Street, New York 18, N. Y.

JANUARY 27-31, 1947—7th International Heating and Ventilating Exposition, Lakeside Hall, Cleveland, Ohio. Sponsored by The American Society of Heating and Ventilating Engineers in conjunction with their 53rd Annual Meeting. Charles F. Roth, manager, International Exposition Co., Grand Central Palace, New York 17, N. Y.

APRIL 7-10, 1947—Annual Convention of The National Association of Corrosion Engineers, Palmer House, Chicago, Ill. Executive Secretary, Elton Sterrett, 9 Southern Standard Building, Houston 2, Tex.

AIR